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WEST INDIAN BULLETIN

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VOLUME III.

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WEST INDIAN BULLETIN

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AGRICULTURAL CONFERENCE, 1902.

REPORT OF PROCEEDINGS.

THE FOURTH WEST INDIAN AGRICULTURAL CONFERENCE was opened on January 4, in the Assembly Hall of the Mutual Life Assurance Company, Bridgetown, Barbados, under the presidency of Dr. D. MORRIS, C.M.G., Imperial Commissioner of Agriculture for the West Indies. There were 44 Representatives present, representing the Botanical, Chemical and Educational Departments as well as the chief Agricultural Societies in the West Indies. His Excellency the Governor of Barbados, Sir FREDERIC M. HODGSON, K.C.M.G., His Lordship the BISHOP of Barbados, many members of the Legislature, and the principal Planters also attended the Conference.

The following is the list of the Representatives appointed by the several West Indian Governments to attend the Conference, who were present :-

JAMAICA.

The Colonial Secretary and Chairman of the Board of Agriculture (The Honourable SYDNEY OLIVIER, C.M.G., B.A.)

The Director of Public Gardens and Plantations (The Honourable WILLIAM FAWCETT, B.Sc., F.L.S.)

The Principal of University College, Kingston (Rev. Canon SIMMS, M.A.)

The Superintendent of the Mico Training College for Teachers (A. B. MCFARLANE, Esq.)

The Lecturer in Agricultural Science (W. R. BUTTENSHAW, Esq., M.A., B.Sc.)

The Representative of the Agricultural Society (JOSEPH SHORE, Esq.)

BRITISH GUIANA.

The Government Analyst and Professor of Chemistry (Professor J. B. HARRISON, C.M.G., M.A., F.I.C., F.G.S., F.C.S.)

The Acting-Principal of Queen's College (G. F. FRANKS, Esq., M.A.)

Representative of the Royal Agricultural and Commercial Society of British Guiana (FREDERICK J. SCARD, Esq., F.I.C.)

The Botanical Assistant in charge of Sugar-cane Experiments (ROBERT WARD, Esq.).

TRINIDAD.

The Representative and Vice-President of the Trinidad Agricultural Society (The Honourable G. TOWNSEND FENWICK.)

The Superintendent of the Royal Botanic Gardens (J. H. HART, Esq., F.L.S.)

The Inspector of Schools (R. GERVASE BUSHE, Esq., M.A.)

The Principal of Queen's Royal College (W. BURSLEM, Esq., M.A.)

The Principal of the College of the Immaculate Conception (The Revd. W. CAROLL.)

The Curator of the Botanic Station, Tobago (HENRY MILLEN, Esq.)

WINDWARD ISLANDS.

The Curator of the Botanic Station, Grenada (W. E. BROADWAY, Esq.)

The Inspector of Schools, Grenada (J. A. HARBIN, Esq.)

The Curator of the Botanic Station, St. Vincent (HENRY POWELL, Esq.)

LEEWARD ISLANDS.

The Government Analyst and Agricultural Chemist (The Honourable FRANCIS WATTS, F.I.C., F.C.S.) Antigua.

The Inspector of Schools for the Leeward Islands (C. M. MARTIN, Esq., B.A.) Montserrat.

Dr. H. A. ALFORD NICHOLLS, C.M.G., M.D., F.L.S., etc., Author of *Tropical Agriculture*, and Representative of the Dominica Agricultural Society.

The Curator of the Botanic Station, Dominica (JOSEPH JONES, Esq.)

The Officer-in-charge of the Agricultural School, Dominica DAVID TANNOCK, Esq.)

Representative of the Antigua Agricultural Society (The Honourable C. A. SHAND.)
The Curator of the Botanic Station, Antigua (W. N. SANDS, Esq.)
The Agricultural Superintendent of Sugar-cane Experiments, Antigua (F. R. SHEPHERD, Esq.)

The Head Master of the High School St. Kitts (W. H. MITCHELL, Esq., M.A.)
The Curator of the Botanic Station St. Kitts (W. LUNT, Esq.)

His Honour the Commissioner, Montserrat (F. H. WATKINS, Esq.)
The Agricultural Instructor, Montserrat (A. J. JORDAN, Esq.)

His Honour the Commissioner, Virgin Islands (Dr. N. G. COOKMAN.)

BARBADOS.

The Chairman of the Education Board (His Lordship the Bishop.)
Representatives of the Barbados Agricultural Society (The Hon'ble F. J. CLARKE and W. D. SHEPHERD, Esq.)
The Head Master of Harrison College (HORACE DEIGHTON, Esq., M.A., F.R.A.S.)
The Island Professor of Chemistry, in chemical charge of Sugar-cane Experiments (Professor J. P. D'ALBUQUERQUE, M.A., F.I.C. F.C.S.)
The Agricultural Superintendent of Sugar-cane Experiments (J. R. BOVELL, Esq., F.L.S., F.C.S.)
The Lecturer in Agricultural Science (LONGFIELD SMITH, Esq., PH.D., B.SC.)
The Inspector of Schools (Rev. J. E. REECE, M.A.)

OFFICERS

OF THE IMPERIAL DEPARTMENT OF AGRICULTURE FOR THE WEST INDIES.

Commissioner (D. MORRIS, Esq., C.M.G., M.A., D.SC., F.L.S.)
Travelling Superintendent (GEORGE WHITFIELD SMITH, Esq.)
Technical Assistant (WILLIAM GEORGE FREEMAN, Esq., B.SC., A.R.C.S., F.L.S.)
Entomologist (HAROLD MAXWELL-LEFROY, Esq., B.A., F.E.S.)
Mycologist and Agricultural Lecturer (ALBERT HOWARD, Esq., B.A., A.R.C.S., F.L.S., F.C.S.)
B. MASON, Esq., Miss ROBINSON and the Acting Secretary to the Conference, ALLEYNE GRAHAM HOWELL, Esq.

Owing to the Quarantine regulations in force against St. Lucia, the Representatives of that island were unable to attend. The Conference was thus deprived of the Inspector of Schools (F. E. BUNDY, Esq.), The Curator of the Botanic Station (J. C. MOORE, Esq.), and the Agricultural Instructor (GEORGE S. HUDSON, Esq.)

The Island and Agricultural Chemist for Jamaica (H. H. COUSINS, Esq., M.A.), the Inspector of Schools for British Guiana (WILLIAM BLAIR, Esq.), the Government Analyst and Professor of Chemistry for Trinidad (Professor P. CARMODY F.I.C.), the Representative of the Grenada Agricultural Society (F. HARFORD Esq.), the President of the Barbados Agricultural Society (Honourable Sir GEORGE C. PILE, Kt.), and the Principal of Codrington College (Rev. Canon BINDLEY, M.A., D.D.), were also prevented from attending.

Amongst those present at the opening ceremony were, His Excellency the GOVERNOR, with Lieut. BERTHON, A.D.C.; Mrs. FOORD-HILTON, Mrs. SWABY, Mrs. MORRIS. Mrs. W. G. FREEMAN, and the Misses BURTON; His Excellency Major-General FOORD-HILTON; His Lordship the BISHOP; the Acting Chief-Justice (Hon. W. K. CHANDLER, LL.D.); the Colonial Secretary (Hon. F. J. NEWTON, C.M.G.); the Attorney General (Hon. W. H. GREAVES, K.C.); the Solicitor General (Hon. G. A. GOODMAN); the Auditor General (E. T. GRANNUM, Esq.); the very Rev. Dean PHILLIPS; Hon. T. KERR, C.M.G.: Hon. J. GARDINER AUSTIN, M.L.C.; Hon. W. P. LEACOCK, M.L.C.; the Inspector of Police (Major A. B. R. KAYE); Rev. Canon SMITH; R. J. CLINCKETT, Esq., M.C.P.: T. W. O'NEAL, Esq., M.C.P.; H. W. REECE, Esq., M.C.P.; H. E. THORNE, Esq., M.C.P.; J. W. C. CATFORD, Esq., M.C.P.; FORSTER M. ALLEYNE, Esq.; E. T. RACKER, Esq.: V. GALE, Esq.; R. R. HALL, Esq.: Dr. J. HUTSON; Dr. C. ST. JOHN; Dr. MANNING; E. F. S. BOWEN, Esq.; and a representative gathering of Planters, members of the Civil Service, and the mercantile community.

The Representatives were received in the Conference Hall at 10.30 a.m., by His Excellency the GOVERNOR, who opened the proceedings with the following speech: -

Before we proceed to serious business it devolves upon me to express to those present here to-day, as Representatives to the West Indian Conference, the great pleasure which it gives the Colony of Barbados to receive them at this the fourth annual Conference held under the auspices of the Imperial Department of Agriculture for the West Indies. I do not intend to detain you, because your time is very limited and you have a good deal of important work to get through; but I may be permitted to say that while you look back with much pride upon the work already accomplished both in the improvement of agricultural methods and the education of the rising generation in agricultural matters, there is still more and very much more to be done. The fact that there are so many of you here to-day is, I think, an indication that your zeal to assist in carrying out the objects for which the Agricultural Department was brought into existence, has in no way abated. And we may look forward with some hope to the time when, backed up by your

efforts, the commerce of the West Indies will be placed upon a satisfactory footing and kept there. That is what we have to strive for. In welcoming you here I do so most heartily, and I for one hope that the result of this Conference will take us some degree nearer that end. (Applause.)

I. THE PRESIDENT'S ADDRESS.

Dr. MORRIS then rose and said :—

I have pleasure in opening to-day the fourth West Indian Agricultural Conference. There are several new members and to them, as well as to the tried Representatives of former years, I tender a hearty welcome.

It is an encouraging feature that the number of the unofficial Representatives is steadily increasing, showing that members of the planting community are taking a deeper interest in these gatherings and anxious to keep in touch with what is going on.

We are here to discuss numerous subjects intimately connected with the well-being of these Colonies, and I trust that the results of our deliberations will be of permanent benefit to them.

These Annual Conferences are recognised as most important means for the interchange of ideas and for stimulating renewed efforts in the work entrusted to us. They have, as you know, received the special approval of His Majesty's Secretary of State and have been adopted, after due deliberation, by the several West Indian Governments. They are, therefore, an integral part of the policy of the State to assist in the agricultural and educational development of these Colonies.

It would, I admit, add to the interest of these Conferences if we could change the place of meeting and visit each Colony in turn. Proposals in this direction have been often discussed but, so far, I regret to say without success.

The business to be brought before us is set forth in the Programme of Proceedings already in your hands. It has been steadily kept in view to limit the number of papers so as to admit of fuller discussion on points of interest. It is hoped that those in a position to contribute information on matters immediately within their knowledge will not hesitate to do so. The discussion is often of as great, if not of greater value, than the paper itself, and it is the object of these gatherings to encourage a wide exchange of ideas and place on record the varied conditions and problems to be dealt with in each Colony.

We cannot, within the short space of time at our disposal, go into great detail and present some of the finer results of the researches in which we are severally engaged. This is an age of detail, but such results as I have referred to are more suitably presented in separate publications and studied in such leisure as the exigencies of a busy life permit. We have here to deal with general principles and if we agree

on these we shall find that our several aims and methods will vary only according to the conditions of our environments.

We have at former conferences given so prominent a place to questions affecting the sugar industry that it is not possible to-day to do more than review the efforts of the past three years and carefully compare the results. In the case of Jamaica there will be presented papers descriptive of the present condition of the sugar industry in that island with suggestions for improvement. In the Educational Section we similarly propose to review past efforts, and, to use a colloquialism, take stock of the situation and see exactly where we stand. I have the belief that in no department of our efforts are the prospects on the whole so favourable as in the educational.

In the General Section numerous subjects claim our attention, some of them of considerable and immediate importance. The paper to be presented by Mr. Olivier containing suggestions for controlling the quality of exported fruit opens a question that, sooner or later, will require to be fully dealt with in these Colonies. At present it is possible for unscrupulous persons without let or hindrance, to export (on commission or otherwise) inferior or damaged fruit in any quantity and for any period, leading to the ruin of a promising industry. This applies more particularly to such fruit as oranges, limes, mangos and pine-apples. If these Colonies are to prosper we cannot neglect any of our opportunities. We should on the other hand take all reasonable action in the interest of those concerned to conserve and develop every advantage we enjoy due to our favourable soil and climate and to our geographical position in relation to the markets of Europe and the United States of America. The other papers in this Section will deal with the present position of the Banana industry in Jamaica, the preparation of Essential Oils, the Aloe industry of Barbados and the artificial drying of Cacao at Grenada and Dominica.

SUGAR INDUSTRY.

Interest in the experiments carried on with the view of improving the yield and quality of the sugar-cane is maintained. Further knowledge and experience show that the experiments are on right lines, though as might naturally be expected the results of any one year do not necessarily follow exactly those of the preceding year. As I stated last year 'the problem before us is to work out by patient and reliable experiments over a number of years the characteristics of various canes and recommend ultimately only those that after exhaustive trial are suited to each locality. To attempt to force the cultivation of one variety under all circumstances cannot but end in failure.' In spite of this very definite statement as to the impossibility of producing an 'all-round cane,' it has been advanced as an argument against these experiments that they have hitherto failed to produce a seedling which, as an all-round cane, can take the place of varieties already cultivated. The actual results of the experiments completed in 1901 will, I hope, be placed before you by the investigators themselves. A summary of those for Barbados and the Leeward Islands

were, in the first instance, communicated in short addresses to the members of the planting community several weeks before the planting season came on These have since been published in pamphlet form and are now before you.

As I have stated elsewhere, Annual Reports on experiments of this nature are necessary evils; but if they are judiciously utilised the planters are placed in a better position in the long run, than if they have to wait for years before any results whatever are placed before them. This does not prevent such reports being, afterwards, revised and corrected and the results of several years' work summarised for general information. I shall not anticipate the authoritative statements to be laid before you by the officers-in-charge of the experiments but I may say that, I see no ground for qualifying in any degree what was stated last year as to 'a reasonable hope of our being able to increase the sugar contents of the cane and eventually of placing within reach of the planter some cane [or other] that will not only yield 40 to 50 per cent. more sugar than at present, but will also, if placed under suitable conditions, withstand to a considerable extent the attacks of disease.' The yield of any particular cane even in the same land must vary from year to year depending on the amount and distribution of the rainfall. Temporary fluctuations of this nature are inevitable; but if they are clearly placed on record, so far from being cited as evidence of failure they should be accepted by those concerned as the strongest proof that the results are faithfully and honestly declared.

The Reports dealing with Manurial Experiments are no less valuable than those relating to testing seedling and other canes. Manuring is a necessity in most of these Colonies, but as to the particular sort of manure to be applied and as to the amount and time of applying it in each case we have yet much to learn. We are still engaged in investigations with regard to the chief requirement in all sugar-cane manures, viz: the amount of available nitrogen in order to determine the quantity that can be economically applied in average years and the advantage or disadvantage of the manuring being done in one or more applications. The reports on manuring published during the past year include one of considerable interest by Mr. Watts and his colleagues giving a detailed account of manurial experiments carried on at Antigua and St. Kitts. Another report by Professor d'Albuquerque and Mr. Bovell gives the results of experiments with manures and leguminous plants at Barbados. Both these reports have been widely distributed and are familiar to you.

The diseases of the sugar-cane still demand strenuous effort on the part of the planting community to keep them in check. The most prominent of the enemies of the sugar-cane in the West Indies is undoubtedly the moth-borer. This not only directly injures the cane but enables the fungus to gain access and ultimately to infect every portion of it. It is undeniable that if, at a small cost, vigorous efforts were made to collect the eggs of the moth-borer on all the young canes, especially after the reaping of the old canes, and this practice, with the regular cut-

ting out of 'dead hearts,' were continued for three successive seasons, the saving to the planter in rotten canes would amount to several thousand pounds per annum. These are days when profits are steadily diminishing: hence the need to prevent loss in every possible direction.

The fungoid diseases are also capable of being dealt with. First of all, only perfectly healthy 'tops' should be used for planting and if these are treated beforehand with some preservative or disinfectant all the better. Next, not a single rotten cane should be left on the land, or stacked for fuel by the peasantry, or allowed to accumulate in the mill yards. All should be scrupulously collected, passed through the mill and burnt. These are simple remedies, and if rightly carried out they are as effective as they are simple.

The question of starting Central Factories in some of the smaller sugar islands, it is hoped, has approached a stage when the details may be submitted to the consideration of the planting community. It would appear that in Barbados the opinion is not unanimous, owing to special circumstances, that Central Factories would materially improve the condition of all classes of the community. It should however be borne in mind that Central Factories could only be introduced very gradually: and if a pioneer factory were started in the first instance and the results carefully watched there would then be time to decide whether the system was advantageous or not. As long as nothing is done it is difficult to look forward with any degree of comfort to the future of the sugar industry in this island. At Antigua, it is understood that proposals for a factory are fairly well advanced.

The sitting of an International Sugar Conference at Brussels to consider the desirability of abolishing Sugar Bounties affords a hope, in which we heartily join, that such 'agencies of economic unwisdom' will at last disappear. The members of the West India Royal Commission placed on record that 'the benefits which the British Empire as a whole derives from any lowering of the price of sugar due to the operation of the bounty system is too dearly purchased by the injury which that system imposes on a limited class, namely, Your Majesty's West Indian and other subjects dependent on the sugar industry.' It is appropriate that this representative West Indian gathering should appreciate the efforts that have been made to get rid of bounties, express sympathy with those who have suffered from them, and look forward to some relief as the result of the present Brussels Conference.

OTHER INDUSTRIES.

Next to sugar come the important Cacao industries of Trinidad, Grenada, St. Lucia and Dominica. Efforts are being made by the more intelligent planters in these Colonies to improve the system of pruning and apply tar to cut surfaces, as well as to drain and fork the land and apply suitable manures. In respect of diseases, these have recently received considerable attention from the Imperial Department of Agriculture. While the attacks of 'thrips' have not seriously increased anywhere

they still require careful attention on the part of the planter. Fungoid disease affects the pod, the stem and the roots. The diseases of the pod, require that all those showing blotches or discolourations should be gathered at once, and that these as well as all empty husks or shells should be buried, preferably with lime to hasten decay. The best preventive for canker of the stem and branches is to tar all cut surfaces; while in cases of root disease the affected tree or trees should immediately be isolated by a deep trench and all diseased roots dug up and burned before a fresh tree is planted in the same place.

With the view of testing practically a simple method of curing cacao during wet seasons, a cacao drying house has been constructed by the Imperial Department of Agriculture at the Botanic Station at Dominica. A brief description of this has already been published (*West Indian Bulletin*, Vol. II, pp. 171-174). The general subject of artificially drying cacao will come up for consideration at this Conference.

Experiments have been started to determine the best treatment for lime trees at Dominica, including manuring on poor lands. Mr. Watts will read a paper on the preparation of citrate of lime and indicate the circumstances under which it might be advantageous for the planter to export the citrate rather than juice. Hitherto citrate of lime has not been regularly exported from the West Indies.

At St. Vincent, where the only arrowroot industry in these Colonies has been continuously maintained, a general attempt is being made by the producers to regulate the supply and not overstock the market. It would be useful also to improve the standard of quality of the exported article and thus regain the good name that once attached to St. Vincent arrowroot. A few of the best brands have continued to obtain fair prices.

An attempt is being made by the Imperial Department of Agriculture to establish a trade in Sweet potatos between Barbados and London. All the potatos so far shipped have been easily disposed of. A pamphlet was issued by the Department giving full directions as to preparing and cooking sweet potatos, and distributed with the potatos. The prospects of the experiment are, at present promising.

In order to tide over recurring periods of scarcity amongst the inhabitants of Anguilla it has been proposed to utilise the crops of sweet potatos produced during one period of the year by converting them into meal. By actual trial sweet potato meal, in quantity, has been produced at the neighbouring island of Antigua at a cost of a half-penny per pound. It will keep for more than twelve months and is a palatable and nutritious food. A slicing machine and a small mill have been provided for experimental use at Anguilla.

The onion industry at Antigua is extending, and a similar industry is being started at Montserrat and Dominica. The experiments mentioned last year as being carried on with the view of establishing an industry in early potatos for the English market, are being renewed this year with imported seed.

The paper read at the last Conference by Mr. Hart on

'Rubber planting in the West Indies' has received considerable attention. The best tree to cultivate in the West Indies is undoubtedly the Central American rubber (*Castilloa elastica.*) There is a possible opening for rubber planting, either separately or with cacao, at Trinidad, Tobago, Dominica and Jamaica. The plantations already started at Trinidad and Tobago will shortly show to what extent cultivated trees are as productive as those in a wild state, and whether the industry offers a suitable return on capital.

In spite of the very favourable conditions that exist in many of these Colonies for raising horses, cattle and small stock, these are at present largely imported from foreign countries. With the view of improving the breed of native stock, the Imperial Department of Agriculture is assisting the smaller Islands to the extent of about eight hundred pounds to enable them to import stallion ponies, Maltese jacks and jennies, pedigree bulls, pigs, sheep, goats and poultry.

Bee-keeping is another industry that is being encouraged in suitable localities. A bee-expert was employed for several months to visit and advise bee-keepers and lately an illustrated pamphlet containing information respecting bee-keeping in the West Indies has been published.

The direct fruit trade between Jamaica and the United Kingdom, since we last met, has proved entirely successful. This is an event of great importance to these Colonies. It is difficult to over estimate the possibilities in this direction, provided we are determined to learn not only how to grow choice fruit but also to select and ship it in good condition. Many of the smaller West Indian islands such as Grenada, St. Vincent, St. Lucia and Dominica should take an active part in a fruit industry. Excellent oranges from Dominica have been successfully shipped to England for many years by the Royal Mail steamers and recently a trial shipment of bananas was also made from that island.

AGRICULTURAL EDUCATION.

The lectures to teachers in charge of elementary schools have been continued throughout the West Indies. At Jamaica, two very successful courses of lectures were organised by the Board of Agriculture, one at Kingston to sixty teachers for four weeks, and the other at Bethlehem to twenty teachers for the same period. The results in both cases were most satisfactory. In regard to the lectures at British Guiana and Trinidad the educational officers will, I hope, be in a position to place the facts before us to-day. At Barbados and in the Windward and Leeward Islands practically all the teachers have now received instruction sufficient to enable them to include a certain amount of the teaching of elementary science and of agriculture in their schools. Also the several Codes have been adapted to admit of grants being offered to encourage attention being given to these subjects. Blackie's *Tropical Readers* are used for general class work and latterly the Imperial Department of Agriculture has published a text book for teachers, prepared by Mr. Francis Watts, entitled *Nature Teaching.*

This especially deals with West Indian conditions and is intended to be of service in indicating not only the kind and amount of information that should be given, but also the requisite illustrations and experiments. A pamphlet containing 'Hints for laying out and planting School gardens' has also been published. In a few cases School gardens are attached to the Botanic and Experiment Stations and the teachers receive assistance from the officers-in-charge. It is important that School gardens should be started only after careful consideration and where the cost is provided beforehand. It would be preferable in most schools to start with raising seedlings and cuttings in pots and boxes and gradually extend operations as required. In all cases the books mentioned above should be closely studied.

Agricultural teaching in Secondary Schools and Colleges will depend in the first instance on boys remaining at school until they have received a sound general education, and secondly on arrangements being made for teaching elementary science in the lower forms. Where no provision is made for the latter, agricultural teaching in the true sense is impossible. Lecturers in Agricultural Science are maintained from the funds of the Imperial Department of Agriculture at Jamaica and Barbados. These were the only Colonies in a position, three years ago, to avail themselves of the opportunity then offered. At Jamaica the Government has reported in high terms of the results of Mr. Buttenshaw's services. At Barbados, where the teaching of elementary science had already been carried on, the Cambridge Examiners were able to report, last year, as one of the results of the employment of the Lecturer in Agriculture, that in Agricultural Chemistry, Practical Chemistry, Botany, Physics and Meteorology, Physiology and Entomology, the teaching 'was highly satisfactory.' Further, a student (Ernest Melville Cutting) from the Agricultural Class has lately won the Barbados Scholarship in Science. The Examiners stated that Cutting's work was 'distinctly up to the standard of that of a successful candidate for an entrance scholarship at Trinity College or St. John's College.' Cutting has since entered the latter College.

The seven scholarships in Agriculture, including two of the annual value of £75 each for the Windward and Leeward Islands, are still in force. As funds admit, it is proposed to increase the number of these scholarships to afford opportunity to the most promising boys in the smaller islands to obtain sound agricultural teaching.

The Agricultural Schools at St. Vincent, Dominica, and St. Lucia are now established. About seventy selected boys, from fifteen to sixteen years of age, preferably the sons of small proprietors, are being maintained at these schools free of cost to their parents, and carefully trained in the science and practice of agriculture. Attached to the schools are Experiment Stations where the boys carry on all light operations and raise a portion of their own food. It is proposed in addition that they should be regularly trained in budding and grafting fruit trees, be engaged in growing and prepar-

ing produce for export, have charge of stock, and learn bee-keeping. The full course is intended to last for three or four years according to age at admission.

At the request of the Barbados Agricultural Society a series of seven lectures to planters was delivered by the Officers of the Imperial Department of Agriculture in September and October last. The subjects dealt with were the natural history of the sugar-cane, soils and manures in relation to the cultivation of the sugar-cane, hints on the planting and cultivation of the sugar-cane, insect pests of the sugar-cane and the fungoid diseases of the sugar-cane. These lectures were attended by about 120 to 140 planters and appeared to be greatly appreciated. The Barbados *Agricultural Reporter* stated 'the lectures were most timely and calculated to be of considerable benefit to planters.' The full text of the lectures, with illustrations, is in course of being published.

BOTANIC AND EXPERIMENT STATIONS.

The Botanic and Experiment Stations under the charge of the Imperial Department of Agriculture at Tobago, Grenada, St. Vincent, Barbados, St. Lucia, Dominica, Montserrat, Antigua, St. Kitts-Nevis and the Virgin Islands are intended not only to be attractive as exhibiting good cultivation of tropical plants, but to afford valuable services in raising and distributing economic plants and to supply information to planters. The Gardens at Grenada, St. Vincent and Dominica take rank with any in the tropics. There are numerous Experiment Stations maintained for the improvement of the sugar-cane, at Barbados, Antigua and St. Kitts and similar stations are attached to the Agricultural Schools. In addition to the Curators of the Botanic Stations, there are Agricultural Instructors employed to travel in the country districts to afford information and take charge of experiment plots to serve as object lessons in the improved cultivation of cacao, limes, coffee and other crops. When the scheme is completed seven Agricultural Instructors will be entirely employed in this work.

AGRICULTURAL SHOWS.

Very successful shows under the auspicies of the Imperial Department of Agriculture are now regularly held at Grenada, Barbados, St. Lucia, Dominica, Montserrat, Antigua and the Virgin Islands. So far it has not been found possible to hold shows at St. Vincent and St. Kitts-Nevis. There is evidence that these shows are gradually drawing attention to the better cultivation and preparation of produce, and they also bring prominently into notice the varied resources of the islands. About £300 are offered every year in prizes by the Imperial Department of Agriculture, and about 100 'Diplomas of Merit.' The latter (lithographed in colours) are intended to be awarded in lieu of money prizes, and are highly appreciated for their attractive and permanent character.

PUBLICATIONS

Of the Journal of the Imperial Department of Agriculture (*West Indian Bulletin*), the last number of the second volume (the eighth of the series) is now in the press. In addition, twelve *Pamphlets*, containing in the aggregate 417 pages, have been published since the last Conference. These pamphlets contain information specially applicable to tropical conditions, and 30,000 copies are in course of being distributed. The principal subjects dealt with are 'The General Treatment of Insect Pests' (First and Second editions), 'Scale Insects of the Lesser Antilles' (Part I), 'Cultivation of Vegetables,' 'Hints for cooking Sweet Potatos,' 'Bee-keeping in the West Indies,' 'Manures and Leguminous Plants at Barbados 1898-1901,' 'Hints for School Gardens,' 'Seedling and other canes in the Leeward Islands 1900-1901,' 'Seedling and other canes at Barbados 1901.' Of *Nature Teaching* (pp. xii and 199) already referred to, 2,000 copies have been published and nearly all distributed. The *Leaflets* issued are: 'The treatment of Black Blight on cultivated plants,' 'Root Borer of Sugar-cane,' 'Weevils in Food,' 'Sweet Potato Worm,' 'Treatment of Sweet Potato Worm,' and 'Note on Porto Rico and Barbados Molasses.'

This is a brief review of the Agricultural efforts of the past year. I trust it will be supplemented in many particulars by those present at this Conference who have so largely shared in the work. We are still in the pioneering stage: but I trust that the facts that are being placed on record from year to year wil' encourage us to renewed efforts, and that we shall win the hearty support and sympathy of all classes of the community whose interests we strive to promote.

The Hon'ble SYDNEY OLIVIER, C.M.G. (Jamaica): It has been intimated to me that the members of the Conference would have no objection if I volunteer to act as their mouthpiece in expressing very briefly to his Excellency their gratification and thanks for the welcome he had been good enough to give them, and also to the President their appreciation and thanks for the extremely interesting, satisfactory, and promising survey of the past and anticipation of the future which he has given in his opening address. I am sure that all of us heartily feel the value of these Conferences, and how much we owe Dr. Morris for his services during the past three years, and how much we shall owe him for his services in the future. There is nobody in the room, perhaps, better qualified than myself to speak in recognition of the work Dr. Morris has undertaken, and the success which has so far attended it. I have known Dr. Morris' work in the West Indies for nearly twenty years, and have had the privilege of serving with him in more than one West Indian Colony. When the Royal Commission came out to the West Indies, in 1897, I, along with Dr. Morris, visited each of the Colonies and studied and became acquainted with their economic conditions. I have seen the idea of what

could be done for the agriculture of the West Indies developing itself in Dr. Morris' mind; I have seen him pressing on with it and trying to put it into practice. I have seen him assisting in formulating the idea set forth in the Commission's report, which formed the basis for the formation of the Imperial Department. Each of us no doubt thinks himself an enthusiast in agricultural matters, but although each man may think that in his own country he is qualified to do something to develop its resources yet, I assert, there is no man in the West Indies who knows more than Dr. Morris what can be done to develop the resources of these Colonies; consequently, when he addressed us in the manner he has to day we were rejoiced and heartily glad to hear that so much substantial progress had been effected in the last two or three years. We have assembled here to pick one another's brains and thus get ideas to take home to our respective Colonies and develop in the interest of our Colonies. It is due to the Imperial Department of Agriculture that we have an opportunity of doing so. I was exceedingly gratified at hearing from the President of the solid work done in other Colonies besides Jamaica, and especially pleased to hear also, that he was satisfied with the progress in the educational work of the Colonies. In some of the Colonies where sugar is the only product, the work of the Department might be confined to the carrying on of experiment stations for sugar-cane; but in Jamaica where there are various industries, it is different; and we cannot hope for any great progress or any great future for the island without an enormous development of the general intelligence and education of the population. This is what we all feel and therefore it was with the greatest satisfaction we heard the President say that the education in these Colonies is full of promise. In behalf of the Conference I beg to tender thanks to his Excellency for his welcome to Barbados, and to give an earnest assurance to Dr. Morris that we have come here with a desire to make the Conference a success. Once again I beg to tender the President our thanks with that assurance.

The Hon'ble FRANCIS WATTS (Leeward Islands): I have the honour to second the vote of thanks to our President, Dr. Morris. Few of us are, I think, aware of the immense amount of thought, care and time occupied in preparing for the Conference which holds such a brief session in this island every year. Those of us who have been working in these Colonies some years are able to measure the value of the Conferences. We can remember how in the past, in our isolated islands, we struggled along, each man trying to solve his own problems, each man fighting his own difficulties, and oft times becoming discouraged. But now, year by year, we come into contact with men who have met similar difficulties and overcome them, and can teach us to do likewise. These Conferences are of immense value to us, no matter on what line of work we are engaged. I am pleased at the solid work which has been already done, and having regard to the outlook foreshadowed by Dr. Morris in his address I am able on behalf of the Conference to assure him of our hearty support. I heartily second the vote of thanks to his Excellency, and beg to assure Dr. Morris of the

gratification it affords us to be present here to-day, and that the work will go forward, not only now, but in the future.

After the retirement of visitors the Conference proceeded with the business of the day.

II. SUGAR INDUSTRY.

(1) The discussion on 'Recent Experiments with Seedling and other Canes' was opened by Professor J. P. D'ALBUQUERQUE (Barbados). He referred to the Pamphlet which had recently been issued by the Department of Agriculture, describing the results of the experiments of the past season in Barbados. He summarized the progress already made in Barbados, described the present lines of experiment, and indicated the advances which were hoped for in the near future. Mr. F. J. CLARKE (Barbados) and Mr. W. D. SHEPHERD (Barbados) discussed the experiments.

The Hon'ble FRANCIS WATTS (Leeward Islands) gave an account of the sugar-cane experiments in Antigua and St. Kitts. The detailed Report of these was published in August, and a pamphlet epitomising the more important points in November. Further information was contributed by Mr. C. A. SHAND (Antigua).

Mr. J. H. HART (Trinidad) reported briefly the present position in regard to sugar-cane experiments at Trinidad. The Hon'ble G. T. FENWICK (Trinidad) also spoke.

Professor J. B. HARRISON, C.M.G., (British Guiana), in the absence of a published official report, gave an account of the main lines on which sugar-cane experiment work has recently been carried on in British Guiana. One important feature has been the trial of canes on an estate scale, in addition to the necessary small plots. Reliable facts have thus been obtained with regard to many industrial questions which cannot be satisfactorily answered from small plot experiments alone.

The discussion was summarized and closed by the President.

The Conference then adjourned for luncheon.

(2) After luncheon, papers were contributed by Mr. H. H. COUSINS, Government Chemist for Jamaica, and Mr. JOSEPH SHORE, on the 'Sugar Industry of Jamaica.' In the absence of Mr. COUSINS his paper was read by Mr. W. FAWCETT. It dealt with the condition of the sugar industry in Jamaica as a whole, and with more detail in each of the important districts of the island. Soil analyses, and much other important scientific information was given, and in conclusion he offered suggestions for the improvement of the industry, the future of which Mr. COUSINS looked forward to with great hope. Mr. SHORE's paper gave an interesting account of the industry from the planter's stand-point. He stated that under specially favourable conditions canes could be produced for 6s. per ton. The papers were discussed by Mr. FRANCIS WATTS

(Leeward Islands), Mr. SYDNEY OLIVIER (Jamaica), and the PRESIDENT.

(3) Mr. ALBERT HOWARD, Mycologist to the Imperial Department of Agriculture, read an interesting and valuable paper on the 'Field Treatment of Cane "tops" with reference to Fungoid Diseases.' He showed that the mortality which at times occurs amongst planted cane tops is due to fungoid attack, and described, with the aid of specimens, experiments he had recently carried out to find a means of preventing such loss. As the result of his experiments he recommended treating the cut ends of the tops with Bordeaux mixture and tar.

The paper was discussed by Mr. C. A. SHAND (Antigua), Mr. F. WATTS, Mr. F. J. CLARKE (Barbados). Mr. W. D. SHEPHERD (Barbados) and Mr. J. R. BOVELL (Barbados).

(4) Mr. H. MAXWELL-LEFROY, Entomologist to the Imperial Department of Agriculture, gave an account of the life-history, habits and geographical distribution of the Lady-bird weevil (*Sphenophorus sacchari*), and offered suggestions as to the methods of best preventing its attacks. The paper was illustrated by coloured drawings. An interesting discussion ensued in which Mr. C. A. SHAND (Antigua), Mr. FRANCIS WATTS, Mr F. J. CLARKE (Barbados), Mr. J. H. HART (Trinidad), Mr. G. T. FENWICK (Trinidad), and the PRESIDENT took part. Mr. H. M. LEFROY replied to some questions which had been raised.

The Conference then adjourned until 9 a.m. on Monday.

CONFERENCE DINNER.

The members of the Conference dined together in the spacious dining room of the Marine Hotel at 8 p.m. on Saturday, January 4. The President of the Conference (Dr. MORRIS, C.M.G.) was in the Chair. Covers were laid for forty-two, and besides all the leading members of the Conference and Dr. Morris' official staff, the following guests were present:—

His Excellency, Sir FREDERIC HODGSON, K.C.M.G., Governor; His Lordship the BISHOP; The Honourable F. J. NEWTON, C.M.G., Colonial Secretary; Hon'ble W. H. GREAVES, K.C., Attorney-General; Hon'ble F. J. CLARKE, Speaker of the House of Assembly; G. A. GOODMAN, Esq., Solicitor-General; Hon'ble G. T. FENWICK, Trinidad; Colonel BRUXNER-RANDALL (Lancashire Fusiliers); Hon'ble J. G. AUSTIN, Chairman of the Chamber of Commerce; FORSTER M. ALLEYNE, Esq.; Lieutenant C. P. BERTHON, A.D.C., and T. W.B. O'NEAL, Esq., M.C.P.

The Hon'ble Sir GEORGE PILE, Kt., and His Honor Sir CONRAD REEVES, Kt., Chief Justice were unavoidably absent owing to indisposition.

Dinner over,

Dr. MORRIS rose and proposed 'The Health of His Majesty the King and the Members of the Royal Family.'

The toast was drunk with the accustomed honours.

His Excellency the Governor, Sir FREDERIC HODGSON, then rose and said: My Lord, Dr. Morris, and Gentlemen—I have the pleasure to propose 'Success to the Imperial Department of Agriculture in the West Indies,' and with that toast I shall couple the name of Dr. Morris. (Cheers.) If Dr. Morris had done nothing else but weld together the agricultural interests of the various West Indian Colonies, bringing the labour and research of scientists and agricultural officers into harmonious unity, and making them available in combination instead of singly, and perhaps not always in unison, as was the case previously, he would have done good work and have left his mark. But the Department over which he presides has done a great deal more. It has by its researches and publications afforded us already a considerable amount of benefit. It has created, amongst those who are engaged in agriculture in the West Indies, a desire—I might almost say a thirst—for knowledge as to how best to get the most advantage for the capital which has been invested in agricultural industries. It has disseminated very valuable knowledge in regard to the lines on which numerous industries, including the sugar-cane, should be carried on, and it has made strenuous efforts to provide for the agricultural education of the rising generation. I regard the latter as a very important step. To-day I was struck by two very interesting papers which were read at the Conference —one by Mr. Howard upon 'The field treatment of cane "tops" in reference to Fungoid diseases,' and the other by Mr. Lefroy upon 'Insect Pests.' I do not know whether bounties are fungoid growths or insect pests (laughter) but there is no doubt that they take away from the agriculturist a great deal of his profits and generally very seriously injure the sugar-cane industry. (Hear, hear.) It would be a very easy process and very satisfactory if bounties could be disposed of by immersion in some fluid, or tarred, as was suggested for cane 'tops.' (Cheers.) That however appears to be impossible and outside the range of vision of the Department of Agriculture. We are glad to know however, that the matter is being seriously taken up elsewhere and we are anxiously looking forward to the result. Here in Barbados we are interested almost entirely in the sugar industry, and while bounties affect us very considerably, yet apart from bounties, a great deal could be done by ourselves in placing our industry in a better state. That leads me to the question of Central factories. I was rather surprised to find in the address delivered to-day the statement that there is, apparently, not unanimity of feeling as to the establishment of Central factories in this island. So far as I know, the feeling amongst planters is unaminous. The matter has been before us since 1895 and we have been hammering at it now for nearly seven years. We do not ask for Imperial assistance: we only ask to be allowed to run factories upon our own lines, and upon co-operative principles. (Cheers.) If started, I for one think it would be advisable to take only the amount of sugar sufficient

to pay the cost of manufacture and leave it to the planters to ship their own sugar and make their own arrangements as they do at present. I advocate this course because there would then be less dislocation of trade and of existing interests. At any rate, if we are to hold our own in the struggle for existence, it is absolutely necessary that we should have factories which are equipped with the latest machinery and all modern appliances. Barbados is especially fortunate in being the meeting ground of the delegates attending these conferences, and it has been a great pleasure to me and to those associated with me to meet the delegates here at this the fourth Annual Conference. If the Imperial Department of Agriculture continues to avail itself of the valuable assistance of the scientists and men of knowledge I see around me here to-night, it must continue to be successful and carry out fully the objects for which it was brought into existence. I ask you gentlemen to drink 'Success to the Imperial Department of Agriculture in the West Indies,' and with that toast I couple the name of my distinguished friend, Dr. Morris. (Applause.)

The toast was drunk with the utmost enthusiasm.

Dr. MORRIS in responding said: Your Excellency, My Lord and Gentlemen—This is the fourth occasion on which we have met in this island since the starting of the Imperial Department of Agriculture. I have already referred to the valuable assistance that I have received from the scientific, educational and technical officers from all parts of the West Indies. Also from the Agricultural Societies and their representatives, and from the planting community generally. I have more reason than ever to-night to thank those who have so ably supported me. I am convinced that by starting on modest and careful lines, adhering strictly to the plan laid down for our guidance by the Royal Commissioners and adopted by Parliament we are steadily advancing in our efforts. There has of course been some discouragement, but the hearty and consistent support that has been accorded by the Governors and all the chief executive officers to the Imperial Department of Agriculture has enabled it to overcome numerous difficulties and, in reviewing the efforts of the past three years, I am in a position to state that, on the whole, they are of a satisfactory character. I trust that if we are fortunate enough to meet again next year we shall be able to look with still greater satisfaction upon the results of our labours. Also, as is devoutedly hoped, if bounties are removed and Central factories are erected, we might eventually attain to a period of comparative prosperity for the sugar industry in these Colonies. I thank your Excellency for the kind way in which you have proposed the toast, and you, my Lord and Gentlemen, for the cordial manner in which it has been received. I assure you that I am profoundly in earnest in pushing on with the work in hand and am proud to find that I am supported so heartily not only by those present, but by all who have at heart the true interest of the West Indies. (Cheers.)

His Lordship the BISHOP: I have a toast to propose which will need no words of mine to commend it. It is the 'Repre-

sentatives, and Visitors to the West Indian Agricultural Conference.' I beg to couple with the toast the names of Mr. Olivier, Professor Harrison and Dr. Nicholls. (Cheers).

The toast was drunk with enthusiasm.

Hon'ble SYDNEY OLIVIER, C.M.G. (Jamaica): I did not know that I should be entrusted with the honour a second time to-day of appearing as a spokesman of my colleagues, the Representatives and Visitors at this Conference. I must repeat the expression of the satisfaction it gives us to be present here, and I may say our special satisfaction in being associated together in this particular manner. We have here in several respects quite a unique and, except at previous Conferences, an unprecedented gathering in the history of the West Indies. We have not only the official, agricultural and educational Representatives of all the West Indian Colonies but unofficial gentlemen of distinguished position like Mr. Fenwick (of Trinidad); Mr. Scard (of British Guiana); Mr. Shand (of Antigua); and Mr. Shore (of Jamaica) who are here in a common interest and for a common purpose: that is to say, of advancing the whole industrial interests of the West Indian Province. Speaking for myself and for those who come from Jamaica and other places, I have to thank the people of Barbados for so kindly welcoming us to this centre of civilization. In Barbados one is forcibly struck with the simplicity of the agricultural problems to be solved as compared with other Colonies. I never come here without admiring the condition of equilibrium and excellence to which agriculture has attained. The whole place seems to be cultivated on a complete system. Where you have not got canes, you have yams and corn, and where you have not got yams and corn, you have sweet potatos, and where you have not got sweet potatos, you have sour grass. Therefore, although the question of maintaining your staple industry is a thorny one and will give you a good deal of thinking for some time to come, still you have not got got the various and complicated problems with which we have to grapple in some of the distant regions from which we have gathered. For instance, in Jamaica we have a large peasant population still widely maintaining an almost African system of agriculture. The African system is not to make two blades of grass grow where one grew before, but to cut down, and destroy by burning, large areas of forest growth to grow a few yams or tanniers, or a little ginger. We have to grapple with this primaeval habit. We have to transform a system of wasteful agriculture into a modern system which must be productive of better results. In dealing with various branches of agricultural advancement an interchange of views in a Conference like this is of exceeding great interest. I suppose that in former times the agricultural system of the West Indies was not specially disinterested as, in some places like Jamaica, it had to rely upon trade in deleterious stimulants such as rum and coffee. (Laughter.) Now, in Jamaica, we are largely turning our attention to fruit and we are attempting in some measure to substitute bananas and oranges for the roast beef and beer of old England. I now have the pleasure of giving place to Professor Harrison who comes from

a Colony which has the advantage of us in that it possesses not only agricultural but mineral wealth. I do not know whether Professor Harrison regards the mineral wealth as part of the agricultural resources of the West Indies, but I only wish that we had the prospect of a similar support to the future agricultural prosperity of these Colonies. (Applause.)

Professor HARRISON, C.M.G.: It seems a mistake to ask me to respond to this toast as I am simply a stray bird returned to its nest. (Laughter.)

Dr. H. A. ALFORD NICHOLLS, C.M.G.: I have already attended two previous Conferences and although I am one of Official Representatives of the Leeward Islands, I am not sure whether I am a botanical or an educational authority. In any case, my friend Dr. Morris, has suggested that I should attend and I have done so with pleasure and profit. On this occasion my position is different. Shortly before I left, I received a communication from the Administrator couched in flattering words stating that the Dominica Agricultural Society would be glad if I would represent them at this Conference. I accepted the honour, thinking I should have nothing to do. I am sure, however, that when I inform the Society that I was called upon to make an after-dinner speech and that I did it, that I accomplished for them a very difficult and laborious task. (Laughter.) The oftener I come to Barbados the more I admire it. It seems to me that Barbados and Barbadians take a very high rank, not only in the West Indies, but throughout the civilized world. Barbados has the reputation of being one of the most densely populated countries in the world, and still when you drive through the country the density of the population is not ostensible. There is no doubt that the excellent cultivation carried on in Barbados, the commercial activity of its merchants, the knowledge of its planters, and, speaking generally, the high civilization of this comparatively small island is a matter of astonishment to those who come from the other Colonies. I should like to take exception to some words which have fallen from my friend Mr. Olivier, regarding Dominica. He comes, I believe, from a place at the back of the world called Jamaica (laughter), and he spoke of Dominica as a place in which the peasants cut down forest simply to grow yams. I would point out that Dominica is not a place like that. It is a place to which numerous people, such as the coffee planter from Ceylon, the vanilla planter from Seychelles, and cacao and other planters from various parts of the world come to settle and develop our lands. We are busy planting coffee and cacao and spices and fruit of all kinds. It might be a good place even for people to emigrate to from Jamaica. I assure Mr. Olivier if they come, they will receive a hearty welcome. In conclusion, I should like to express my gratitude and the gratitude of the other visitors for the kind hospitality that has been extended to us by the people of Barbados. (Cheers).

Mr. FORSTER ALLEYNE:—I have the honour of proposing 'The health of his Excellency the Governor.' I have been in an humble way a spectator of his Excellency's close connexion not only with the work of the Imperial Department of Agriculture

but with the question of agriculture generally. During the course of lectures recently delivered by the officers of the Imperial Department in the Planters' Hall, his Excellency was present on every occasion but one; he asked questions and obviously took the keenest interest in the lectures. I need not refer to the interest which he has taken to-day in the Conference. In fact he has interested himself most warmly in all questions that concern the planting community. We thank him most heartily for this and reckon on his support in future. I particularly, who have fought the bounty question for eight and twenty years and spent time and money more than I like to look at, thank him for his support and the manner in which he has backed our efforts. With these remarks, I beg to propose 'The health of his Excellency the Governor.' (Cheers.)

The toast was drunk with enthusiasm.

Sir FREDERIC HODGSON briefly responded and the party then separated.

The Conference resumed at 9 a.m. on Monday, Dr. Morris presiding as before.

III. EDUCATIONAL.

(5). A discussion was held on 'The Results of efforts during the last three years to introduce the principles of Agriculture into Colleges and Schools in the West Indies.' As in the case of the discussion on the sugar-cane experiments the Colonies were taken seriatim, the Inspector of Schools, whenever present, opening the discussion to which the other educational members in turn contributed.

Mr. A. B. MCFARLANE (Jamaica), gave an interesting account of the agricultural training which is given in a thoroughly practical manner at the Mico Training College, Kingston, to teachers who will in the future take charge of elementary schools. Mr. W. R. BUTTENSHAW, the Lecturer in Agricultural Science for Jamaica, read a paper describing the agricultural education in the Colony and how the small settler is gradually becoming influenced owing to the teachers being often small cultivators themselves. An important feature during the past year has been courses of instruction for teachers lasting as long as four weeks, during which a large portion of the time was given to practical work.

Professor J. B. HARRISON (British Guiana) in the absence of Mr. W. Blair, the Inspector of Schools for British Guiana, outlined the present situation in that Colony. One of the chief difficulties to contend with is the great area over which the schools are scattered. Mr. R. Ward also spoke.

Mr. G. BUSHE (Trinidad) presented a report summarizing the progress made in Trinidad. A very satisfactory feature in the agricultural teaching in that Colony is the extent to which school plots have been adopted.

Rev. J. E. REECE reviewed the last year's work in Barbados, where in contradistinction to Trinidad school plots are almost entirely absent owing to the great scarcity of available land.

His LORDSHIP the BISHOP emphasized the want of ability to draw which was noticeable amongst the teachers, and the need for a training college for teachers. His EXCELLENCY the GOVERNOR pointed out the difficulties in the way of founding a training college in Barbados, and indicated the efforts which had been made to obtain one. At present women teachers are sent to Antigua to be trained. He urged the Inspectors of Schools to impress on their Governments the advisability of starting a central West Indian training college.

Mr. J. A. HARBIN (Grenada) read a paper on the work done in Grenada, and the present situation in that island.

Mr. C. A. MARTIN (Leeward Islands) summarized recent endeavours in the Leeward Islands, laying stress on the imporance of school-gardens as a means of improvement. He indicated the outlines of the scheme of instruction which it is proposed to adopt in the future.

Mr. F. H. WATKINS, (Montserrat) and Dr. N. G. COOKMAN (Virgin Islands) also shortly reviewed the condition of agricultural education in their respective Presidencies.

Mr. S. OLIVIER (Jamaica) Mr. A. J. JORDAN (Monsterrat) and Mr. G. T. FENWICK (Trinidad) also spoke.

The PRESIDENT summarised and brought the discussion to a close. He remarked on the discouragement, in some instances, to the establishment of school gardens owing to the plants being stolen. In conclusion he advised that great care be exercised in regard to educational efforts and advised all to work quietly on, waiting patiently for the results which he was convinced would finally come.

During the course of the Educational discussion the members of the Chemical Section withdrew and held a separate sitting to discuss certain technical points. Professor J. B. HARRISON (British Guiana) acted as Chairman of the Section, and Professor J. P. D'ALBUQUERQUE (Barbados) as Secretary. Their report was presented later in the day.

Immediately after the discussion on Education by the main body of the Conference, the Educational Section withdrew with his Lordship the Bishop as Chairman and Mr. C. M. MARTIN (Leeward Islands) as Secretary to discuss certain points submitted to them. Their report was presented later.

IV. GENERAL.

(6). Hon. SYDNEY OLIVIER (Jamaica) read a valuable paper dealing with the vital question of 'Regulating the quality of Exported Fruit.' He pointed out how owing to the action of persons shipping immature or badly packed fruit, there is a very real danger threatening the fruit trade of these Colonies. If such a course is pursued without check, West Indian fruit will earn a bad name, and fail to command the confidence of the

market. He stated that it was impossible to forbid absolutely the exportation of any kind of fruit, however bad, or to give a Government guarantee, after inspection, to all fruit shipped.

He proposed a general scheme, the main features of which were :—

(1) The establishment of a complete register of all growers and packers, with a nominal license for packing houses.

(2) The marking of all packages with name of packer and packing house.

(3) The establishment of standard grades for size and quality of fruit throughout the West Indies.

(4) The inspection of the packing houses, and packages at any point before shipment, by proper inspectors.

(5) The presence of a direct agent in the selling market.

To maintain the standard of fruit it was suggested that inspectors should have power to brand packages found to be wrongly described.

The subject was discussed by the PRESIDENT and Dr. NICHOLLS, (Dominica).

(7.) The Hon'ble FRANCIS WATTS (Leeward Islands) contributed a paper entitled 'Recent information relating to the preparation of Citrate of lime in the West Indies.' He dealt with the question of the preparation of citrate of lime for export instead of the concentrated lime juice, a subject of great importance at the present time to the lime growing islands, such as Dominica and Montserrat. (*West Indian Bulletin*, Vol. II. No. 4.) Dr. NICHOLLS, (Dominica) spoke on the subject.

The Conference then adjourned for luncheon.

(8.) On re-assembling after luncheon Mr. H. MAXWELL-LEFROY, Entomologist to the Department, read a valuable and interesting paper on 'Suggestions for controlling the importation of Insect Pests.' Taking the scale insects in detail as having been more thoroughly studied, he illustrated by means of diagrams the relative numbers of 'native' and introduced species, the proportion of destructive to harmless kinds, how many had reached each island and how many might be expected to be introduced unless precautions were taken in time. Mr. Lefroy then put forward the outlines of a general scheme for controlling the importation of insect pests which will be found in full in the *West Indian Bulletin*, Vol. II, No. 4. The paper was discussed by Dr. NICHOLLS (Dominica), Mr. W. FAWCETT (Jamaica), Mr. J. H. HART (Trinidad), and the PRESIDENT.

(9.) The Hon'ble SYDNEY OLIVIER, C.M.G. (Jamaica) contributed a paper on 'The Organization and Functions of Agricultural Boards' in which he described the constitution and powers of the Board of Agriculture in Jamaica, of which, as Colonial Secretary, he is President. He showed how by its means the Government, through its chief Executive officer, is brought into close connection with all the Agricultural interests of the Colony. Moreover, through the relationships existing between

the Board, the Imperial Department of Agriculture, and the Educational authorities of the island, they were able the better to organize and utilise all the efforts made for the advancement of agriculture in Jamaica. Mr. Olivier was of opinion that similar Boards would be advantageous to the other West Indian Colonies.

Professor J. B. HARRISON (British Guiana) and Mr. G. T. FENWICK (Trinidad) instanced the work done by somewhat similar Boards in their respective Colonies.

(10.) Mr. J. H. HART (Trinidad) read a paper on the 'The Preparation of Essential Oils in the West Indies,' an industry which has never been a prominent one in these Colonies, and which in the past has been mainly connected with Dominica. Mr. Hart exhibited specimens of fifteen kinds of essential oils which he had prepared from plants grown on the lands of the Botanic Department, Trinidad. He discussed the various oils, described their mode of manufacture, and suggested steps which might be taken to encourage the industry. Dr. H. A. NICHOLLS (Dominica) and Mr. W. FAWCETT (Jamaica) discussed the paper, the latter exhibiting a specimen of the oil of *Cananga odorata* which he had prepared.

(11.) Mr. W. G. FREEMAN, Technical Assistant, Imperial Department of Agriculture, read a paper on 'The Aloe Industry of Barbados,' which has now almost dwindled away. Mr. Freeman pointed out the former magnitude of the industry, the exports being some times of more than £7,000 per annum, described the soil, cultivation, and manufacture, indicated the defective methods which led to the decay of the industry, and made some suggestions for the future. Living specimens of Curaçao and Barbados aloe plants were exhibited. The paper was followed by a discussion to which Professor Harrison (British Guiana), Mr. FRANCIS WATTS (Leeward Islands), Mr. W. D. SHEPHERD (Barbados), and the PRESIDENT contributed.

(12.) Mr. A. HOWARD, Mycologist to the Imperial Department of Agriculture, read an interesting paper on 'The Removal of Epiphytic Vegetation from the stems of Cacao and Lime trees.' He argued that the masses of wild pines, mosses, lichens, etc., commonly to be seen covering the stems of cultivated lime and cacao trees, must be injurious owing to their covering up the lenticels, or breathing pores, in the bark of the trees. He was of opinion moreover that they injured the flowers and young fruits. He referred to the methods usually adopted of ridding trees of such growths, and as an improvement recommended spraying with copper sulphate, which he had found successful.

Mr. W. FAWCETT (Jamaica), Mr. J. H. HART, (Trinidad), Mr. G. WHITFIELD SMITH (Travelling Superintendent, Imperial Department of Agriculture), Mr. H. POWELL (St. Vincent), Dr. H. A. NICHOLLS (Dominica), and the PRESIDENT discussed the paper.

Owing to lack of time the following papers were taken as read :—

'The Banana Industry in Jamaica' (The Hon'ble WILLIAM FAWCETT.)

'Artificial Drying of Cacao in Grenada and Dominica' (Mr. G. WHITFIELD SMITH, and Mr. FREDERICK J. HARFORD).

CONCLUSION.

The PRESIDENT: Gentlemen, we have closed the actual business of the Conference. Some papers have, owing to want of time been left over; among them being Mr. FAWCETT'S paper on 'the Banana Industry of Jamaica' which, I am extremely sorry we have not been able to take. I have received the Report of the Educational Section of which his Lordship the BISHOP was chairman, and Mr. MARTIN secretary, but there is no time to read it. The conclusions arrived at by the Section will be printed and circulated: and I trust that members of the Section will study the many points raised and be able to carry them out. I am quite sure that the plan of holding these sectional meetings helps to utilise the short time at our disposal. I have also received the Report of the Chemical Section of which Professor HARRISON was chairman, and Professor D'ALBUQUERQUE secretary. The conclusions arrived at by this Section will also be printed and distributed.

And now it is my pleasant duty to close the proceedings of this fourth West Indian Agricultural Conference. In doing so, I have once more to express my great indebtedness to those gentlemen who have come from various parts of the West Indies to attend the Conference. I know that they have done so at some personal inconvenience, but they have yet come because they have been actuated by a keen desire to assist in the work we have in hand. It is not necessary for me to do more than thank those gentlemen who have prepared papers for the Conference, and I have also to thank those who have acceded to my wish and taken part in the discussions thereon. I am sorry that in some cases the discussions were not as full as they might have been, but yet they have been most interesting.

The Mail is nót yet signalled, and therefore we might have an evening meeting; but I am afraid that if I press you to hold one you might not have enough physical energy available to carry on much business; consequently, I shall forego further meetings. In conclusion, I have to thank you very heartily for your kindness in attending the Conference and for your kind co-operation in the business. I assure you as head of the Imperial Agricultural Department, that I appreciate very greatly your valuable assistance and I trust we shall be spared to go on with the work we have started and find that we are becoming year by year more and more useful to the communities amongst which we live. (Applause.)

Professor D'ALBUQUERQUE (Barbados) then rose and said: Mr. President and Gentlemen,—I rise to propose a vote of thanks to the President for his able conduct of this Confer-

ence. The address with which he opened the proceedings as well as the grasp displayed by him in dealing with the numerous problems that have been placed before us, has, I am sure, commanded the admiration of everyone who has enjoyed the privilege of being present. To me, this Conference has been one of the most interesting and instructive meetings that have ever assembled in Barbados, and I feel sure that we can all go away feeling that we have greatly profited by its deliberations. I am in a position to know the enormous amount of thought, care and labour bestowed by Dr. Morris upon the preparation for these Conferences, and I am sure it must be a source of great gratification to him to know how thoroughly his labours are appreciated by all of us, to know what benefit we have derived from them, and to see a Department that he has conceived and created rising up under his hands, a Department which, I feel convinced, is second in usefulness to none in this part of the British Empire. A large number of us can testify to the solid progress that has taken place during the past few years under Dr. Morris' guidance, and we look forward as the result of his efforts to wide and far reaching development not only in regard to the sugar-cane industry, which stands first in importance in the West Indies, but also in every department of agriculture. Agriculture is our very life and it is not an exaggeration to say that the mission to improve the agriculture of the West Indies stands first in importance to the life of these communities. The capabilities of a Commissioner of Agriculture are therefore of the utmost importance. There are few men who could unite a knowledge and keenness in the large number of subjects which Dr. Morris has brought within the purview of his Department, and the great stress which he places on education shows how thorough is the foundation on which he is basing his superstructure. We are indeed fortunate in possessing Dr. Morris as Commissioner. His single-minded enthusiasm for the mission on which he came out to the West Indies, as well as his tact, judgement and fairness as a leader are well known to all of us. He lives and thinks of one object and no labour is too great for him in accomplishing it.

I think we ought not to part without saying a word on the social side, and I hope I am not out of place in expressing our appreciation of the charming and amiable hospitality of Mrs. Morris. Some of us have the good fortune to enjoy this hospitality very frequently while others must regret that their experience is confined to this annual gathering. I am sure we all recognise how greatly it adds to the pleasure of the Conference and how it aids in bringing us in touch with one another. I beg to move a vote of thanks to the President for the conduct of this Conference. (Cheers.)

Rev. Father CARROLL (Trinidad), in seconding the vote said : It is not necessary for me to say much. We all have been witnesses to the courteousness shown by the President whilst presiding over the Conference from year to year, and I venture to think that those who have listened to him could not but consider it a privilege to be associated in any capacity with Dr. Morris in the great work in which he is engaged.

I believe I am giving expression to the general feeling of this Conference when I record the hope that Dr. Morris will long be spared to carry out, to its ultimate success, the great work he has so successfully inaugurated in the interest of the people of the West Indies. (Cheers.)

His Honour F. H. WATKINS (Montserrat), in supporting the vote said: The Conference has to thank the President for the perfect arrangements he has made for our comfort at the meeting, and to express our admiration at the ability he has displayed in the conduct of the proceedings. In the Presidential address we have had the pleasure of listening to, we heard a clear and brilliant statement of real and substantial progress: and the papers we have also heard read and the discussions that followed them have been of a very high level of excellence. I am sure that the printed report of the proceedings will be found to contain a record not only of high achievement in the past but an earnest of hope and encouragement in the future. All of us do not possess the scientific knowledge which those connected with the Department have, but yet it is a very great satisfaction to know that each in his own little sphere can do something to help on the great work which Dr. Morris has undertaken in the West Indies. In conclusion, I assure Dr. Morris of the loyal support and hearty sympathy of all those who have the true interest of the West Indies at heart. (Cheers.)

The PRESIDENT: I thank you most heartily for your kind expressions, which I thoroughly appreciate. Before the proceedings terminate it is necessary that I should on your behalf express thanks to his Excellency the Governor for his kind reception on Saturday. I desire also to thank, on your behalf, the heads of Departments, especially the Comptroller of Customs, and also the military authorities who have taken a great interest in furnishing the room with tables and have been most anxious that everything should be done to the credit of Barbados. I must say also that the vote of thanks so cordially given me must be shared very largely by the officers of the Department. I must confess that if it had not been for the fact that I was coming amongst a large number of men whose worth I really valued, and whose capacity for working and carrying out the duties entrusted to them I relied upon, I should have shrunk from assuming the responsibilities of the Department under my charge. With regard to the headquarter staff, I can inform you that it is devoted to the interest of the West Indies. I have to thank Messrs. Lefroy, Howard, and Freeman for their interesting papers, which show that they have made themselves acquainted with the circumstances of the Colonies. Mr. Whitfield Smith is a quieter member of the staff, but he travels through the West Indies doing a large amount of useful work, and assisting the officers of the several stations in any way he can. I have also to thank on your behalf Capt. Owen, the Superintendent of the Royal Mail Company, who has made arrangements for your convenience entirely in accordance with my wishes. In conclusion, I again thank you for your vote of thanks and assure you that I shall

be most happy to do anything I can to promote the interests of these Colonies. (Applause).

The Conference of 1902 then terminated.

AGRICULTURAL CONFERENCE, 1902.

(CONTINUED).

In the previous pages a brief Report of the Proceedings has been given: It is now proposed to publish in full the principal papers, with a summary of the discussion upon each:—

RECENT EXPERIMENTS WITH SEEDLING AND OTHER CANES.

BARBADOS.

Professor J. P. D'ALBUQUERQUE: I have been asked by the President to offer a few remarks upon recent sugar-cane experiments in Barbados, with a view to eliciting an interchange of views amongst the technical experts present and the planters who are here to represent the Agricultural Societies. The work that has been done in Barbados during the past year in connection with seedling canes has already been placed, in the form of a pamphlet,* before the members of this Conference who have thus had the opportunity of perusing it and forming some idea of the results. The pamphlet deals, as did a similar one issued last year, exclusively with results of what we call 'select varieties', that is varieties that have survived the eliminating effects of several years' experiments and have thus been selected from a number of varieties for cultivation at the local experiment stations in typical parts of this island, and for comparison, side by side, with the standard varieties at present in cultivation.

In looking at the results so far achieved, it is worth while pointing out that the select varieties reported upon in this pamphlet have been selected from quite a small number of canes, about 400, raised before the advent of the Imperial Department of Agriculture in the West Indies: and this must be borne in mind in estimating the measure of progress already made. The resources which the Imperial Department of Agriculture have placed at our disposal enable us to raise several thousand seedlings every year but it is not until a proportion of these arrive at the 'select variety' stage that we can see the result of the large amount of work being done to-day. As the result of work done before this department existed we cannot say we have raised any cane that would displace the old and standard varieties such as the Bourbon and White Transparent and we have never claimed to have produced such a cane; but I think, nevertheless, that out of this small number of seedlings we have been able to achieve certain solid results.

* *Seedling and other Canes at Barbados, 1901,* being Number 13, of the Pamphlet Series issued by the Department of Agriculture.

Seedling canes were brought into early prominence in Barbados owing to the sudden failure of the Bourbon cane under the attacks of fungoid disease. It was at once noticed in Barbados, and the observation was confirmed in other islands, that some of the seedling varieties were able, in a conspicuous manner, to resist this fungoid disease; and it was on this account that planters were led as early as 1893, to cultivate seedling varieties and 'transparent' varieties as alternatives to the decadent Bourbon cane. A prolonged study of the earlier West Indian seedlings has shown that individual seedlings possess characters that are accentuated in comparison with the characters of their parents. Resistance to fungoid disease is a character common amongst seedling varieties: some seedlings produce a conspicuously large tonnage of cane compared with that produced by standard varieties; some of the seedlings, a small proportion of the total number, are rich in sugar and of a few of these the juice is pure, while in a large proportion of seedlings the opposite characters prevail; some seedlings 'spring' readily from the seed-cane, others do not; and thus I might go through a long list of characters finding some wanting in some seedlings and others wanting in others. The experiments leave a hopeful expectation that from the large number of seedlings now raised every year, we shall be able, by the employment of proper methods, to raise, within a reasonable time, seedling varieties that combine qualities placing them at a distinct advantage over the canes grown to-day: and this expectation I do not think at all optimistic.

CANE B. 147.

Alluding more directly to the results of the past two years, a great deal of interest has been shown in the the cane known as B. 147. In 1900 that seedling came out first on the average results obtained on black and red soils. The second was B. 208. The White Transparent cane, which is the standard variety at present in cultivation in Barbados was, in that year included only on three of the experiment fields and on those fields the average of the results was much less than those produced by B. 147. This we pointed out was the result of one year's work only, and must be accepted strictly as such.

In 1901, B. 147 sank from first to third place, the order being B. 208, which the previous year was second, White Transparent and B. 147. It is worthy of note, however, that although B. 147 lost its position, the actual tonnage of canes produced was larger than that produced in 1900, and the loss of position was due to the fact that the other two varieties had come more forward than B. 147 under the conditions of weather that prevailed during the growth of that crop.

It is most important in reviewing the results to take careful account of the climatic conditions that prevailed. In December 1899 and January 1900, the planting months, the rainfall was favourable to a good spring of young canes. From the end of January to the middle of May we had the usual dry and windy weather of the reaping season. At the middle of May

the rains came in and continued falling at intervals until the middle of October. In October we expected to make one of the largest crops ever seen in this island, but from the middle of October till the crop was reaped there prevailed one long unbroken drought. B. 147 is a cane that germinates slowly and makes little progress until the rains have well set in. The progress from June until August is extremely slow compared with that made by the White Transparent and other varieties during the same period and it is not until September that B. 147 begins to make the rapid progress that usually places it in tonnage in advance of every other local variety. Early in the year you will go round the fields and be despondent about B. 147 when you see how backward it is, but repeat your visit in November and you will be surprised to see the progress that this cane has made during the later part of the rainy season. We all know how important are the late rains in Barbados for the proper ripening of the sugar-cane, but of all varieties B. 147 suffers most from a lack of late rains and consequently of the best known varieties this one suffered most from the effects of the 1900-1 drought. This dependence upon late rains, we have to admit, is a serious drawback to the qualities of B. 147.

Important considerations in an island like Barbados, which is a muscovado island, are the richness and purity of the juice. It is generally recognised that the muscovado form of the sugar industry has been able to exist in the West Indian islands, chiefly on account of the richness and purity of the cane juice. Consequently, when it is proposed to introduce a new seedling variety into that industry we must take into careful consideration the quality of the juice. The purity of the juice of B. 147 in ordinary years is sufficiently high to enable good muscovado sugar to be made, but it does not leave a wide margin for our muscovado pan-boilers. I need not point out the disadvantages under which the muscovado manufacturer labours, and especially when he is without even a steam pan and crushes his cane by wind power. In 1901 there were recurring periods when heaps of canes were waiting several days at the mill to be crushed and were rotting and in such circumstances it is not surprising that B. 147, which in ordinary years does not yield a highly pure juice, should have given the planters in Barbados a great deal of trouble in attempting to make their sugar up to the polariscopic test.

Another important consideration in regard to B. 147 is its ratooning power. We cannot at present speak conclusively on this point. As a matter of fact planters of great experience in ratooning districts have cultivated it as plant canes and failed to obtain a growth of ratoons and the general opinion amongst planters is that it is not a ratooning variety. On the other hand there are instances in which the variety has been successfully ratooned in non-ratooning as well as ratooning districts and I think we ought to suspend judgement rather than condemn it upon this point at this stage. It has hitherto been regarded not only as a late growing but also a late ripening cane and has consequently been cut late. There is also a tendency, owing to its late growing habit, to apply active

nitrogenous manures late in the year which retard the ripening of the cane at the normal time and impair the quality of the juice. Recent observations rather go to show that, though a late grower, it is an early ripener, and late cutting would act, as with all other varieties prejudicially on the spring of ratoons. Bearing in mind however, its slow spring from the seed-cane one would rather expect that it would be backward in ratooning properties.

CANE B. 208.

Referring now to the other seedling variety that has come into prominence, namely B. 208, this cane, under the conditions of weather existing during the season under review, has greatly increased its output of sugar and—a very important point for the muscovado planter—it has fully maintained the richness and purity of its juice. While it is possible that B. 208 may never come into very extensive cultivation or high favour it is promising as an instance where we get richness and purity of juice in a seedling variety that also produces a fair tonnage of cane. We are trying to combine in one seedling two qualities —heavy tonnage of canes and rich and pure juice.

It will be noted in regard to the seedlings cultivated at the Central station, that only some eight varieties have been included amongst the 'select varieties' and grown experimentally at the local stations; and of these we are only able after two years' experiment to recommend two for continued trial. But I do not think we need be discouraged at this result, foi these two were chosen from a comparatively small number of seedlings. With the facilities now at our command and the resources of the Imperial Department of Agriculture, we expect to test from this year onwards some five or six thousand seedlings every year from which we shall rapidly eliminate the worthless individuals and direct our attention to the propagation and study of those that are the more promising.

SMALL PLOT EXPERIMENTS NECESSARY.

At this point I may allude to the necessity of experimenting with seedlings in small plots. The production of improved seedling varieties of sugar-cane is a process of repeated elimination. Large numbers of canes are annually raised from seed, and these are necessarily produced at first in single stools, they are tested, the less promising of them are destroyed, the more promising are propagated and this process is repeated with succeeding crops until the merits of the varieties are determined and at the same time a sufficient number raised to distribute, if necessary, to the local experiment stations; from whence, if results justify it, they can be distributed to the estates themselves. During this repeated testing and propagation a very large proportion of the original seedlings have been discarded and discarded before they have been cultivated on a large scale. To cultivate large numbers of seedlings in Barbados on a large scale is an impossibility and much more an impossibility to cultivate large numbers of seedlings on a large scale in several typical parts of the island. The possibility of producing improved seedling canes depends upon their production in large

numbers and therefore unless many thousands of acres can be requisitioned for unknown—and mostly worthless—seedling canes, small plots are a necessity.

Suppose seed be sown in November, 1901, it will be 1906 before as many as 100 stools can be reaped on one estate; it will be 1907 before 100 stools can be reaped on several estates it will be 1908 before similar plots of ratoons can be reaped on several estates. It would be 1907 before ten acres could be reaped if the preliminary tests of the variety were confined to the original single stools. It would be 1909 before it could be reaped on a large scale after testing only once in 100 stool plots at the local stations. It must therefore be evident if time, land, labour and money are to be economised that small plots are a necessity and are the logical and practical preliminary to fields of canes. Our method is to propagate each variety rapidly up to 100 stools testing and eliminating as we go on: to distribute the fittest that have survived to the local stations where they serve to test for two or more years the value of the varieties in different soils and different typical localities, and under conditions of practical estate working against the staple variety grown at each estate. These local stations serve as useful demonstration fields to the planters who can study for themselves the field habits of the varieties and they serve as useful centres at which to propagate and distribute plants of the best varieties to the plantations in the neighbourhood.

If we relied upon one experiment station for our test we should fail to take into consideration the important effects of variation in soils and climates and after years of experiment and propagation when we came to distribute the variety most promising at the one station, to the plantations in other parts of the island, it would only be to find out that this variety was a failure, and to leave the possibility in our mind that we had discarded some other seedling that would have proved a success. We have an example of that in the Burke cane, which at Dodds for a series of years gave excellent results but when distributed to other parts of the island in every case, except one or two, proved a failure.

The experiments at local stations are carried out first of all in 100 stool plots in duplicate and ten to fifteen varieties are tried at each and all of the stations. These experiments serve to indicate two or three canes of special promise and the next stage is to plant duplicate one acre plots of these on the same or neighbouring estates, to reap the plots separately, to weigh the canes on the estate scales (if the estate possesses scales) and crush them in the estate mill, and measure the juice and analyse it at the Government laboratory. All the results will be published annually and from this point the further cultivation of the varieties will be left to the planters themselves, rendering them such chemical aid as our resources will permit, and welcoming such information as is forthcoming on the comparative results of their trials. Each planter will thus in due course be in a position to select the one or two varieties best suited to the conditions of his estate. I am quite sure, as soon as one-acre plot results warrant it that

the same planters who all over the island are so readily granting fields for our 100 stool and one acre experiments will readily co-operate in extending the cultivation to such areas as will convince all practical men as to the value of any good seedling cane.

MANURIAL EXPERIMENTS.

Passing from the subject of seedling canes to that of manurial experiments with plant canes, I will dismiss the results of the past two years' work in a few words. In Barbados the trash (dead leaves) and cane tops are returned to the land with great care in the farmyard manure and this farmyard manure supplies not only a considerable amount of humus but also returns large quantities of nitrogen, phosphoric acid and potash that otherwise would be permanently removed from the land. The results of my analyses show that the phosphoric acid and potash in this farmyard manure are readily available to the plant and these facts have a considerable bearing on the results of our manurial experiments. The results of our two years' experiments upon four estates have shown that on three of them, when liberal quantities of farmyard manure had been applied, additional phosphoric acid in the form of artificial manure produced no increase in the returns: superphosphate had no effect, basic slag diminished the yield by three tons of produce (that is canes and tops) per acre. On the other hand potash to the extent of 100 pounds of sulphate of potash per acre applied in January led to profitable results. Upon the fourth estate (Dodds' experiment station) both additional phosphoric acid and potash were necessary to obtain the maximum yield under the conditions of rainfall of the years under review: and 250 pounds of basic slag was the most advantageous application of phosphoric acid. It may be mentioned that the soil of this experiment field at Dodds is deficient in the mineral constituents of plant food as well as in carbonate of lime: and in both these respects it differs from the soils of the other manurial experiment stations as well as from those of a large proportion of the island. Nitrogen in an active form (sulphate of ammonia or nitrate of soda) was the most important ingredient of the artificial manures applied, sulphate of ammonia, on the whole, seemed to be a better form in which to apply it than nitrate of soda and the most profitable application was 200 to 400 pounds of sulphate of ammonia according to the condition of the land the quantity and composition of the farmyard manure applied and, most of all, according to the amount and distribution of the rainfall. The application of a small proportion of the active nitrogen to the young cane (in January) was beneficial when it was followed by some early showers, a large proportion of the nitrogen (40 pounds; that is about 200 pounds sulphate of ammonia) was best applied in June, which is at the beginning of the rainy season and of the most active period of cane growth; and after-applications, not later than August, of sulphate of ammonia making the total up to 80 pounds of nitrogen or 400 pounds sulphate of ammonia per acre were only advisable if there was a sufficient period of

rainfall subsequent to the previous application, in other cases the late application of nitrogen was apparently prejudicial to the ripening of the canes. On plots receiving no farmyard manure, phosphoric acid in the form of superphosphate applied in January up to at least 50 pounds phosphate (25 pounds phosphoric acid) per acre produced an increase of yield and larger quantities of active nitrogenous manure could be utilised than on the adjacent plots receiving farmyard manure. It will therefore be apparent that the results of the experiment indicate a manurial treatment varying with the amount of farmyard manure applied. On these fields of plant canes receiving an ample application of farmyard manure 100 pounds of sulphate of potash in January and 200 to 400 pounds of sulphate of ammonia applied largely in June produced the most profitable results, while in the absence of farmyard manure or with a deficiency of farmyard manure the treatment indicated was an early cane manure applied in January supplying 100 pounds sulphate of potash, 140 pounds of 36 per cent. superphosphate and 50 pounds sulphate of ammonia per acre, followed by 200 pounds of sulphate of ammonia in June, with or without a further application of sulphate of ammonia in July or August according as the rainfall and progress of the canes in June and July justified it.

In manurial experiments, as in seedling experiments, small plots are, in my opinion, a necessity. Any one who peruses the portion of the paper read by Professor Harrison at the conference of 1900 dealing with manurial experiments will see what a large number of questions remain to be answered. If these questions are to be answered within a reasonable period, a large number of small plots are necessary, each at least in duplicate, and preferably repeated on the same field many times, in order to eliminate variations in fertility of the soil. It is also necessary that these experiments should be repeated in different conditions of soil and climate and carried over a series of years. This is only practical by the use of small plots which can afterwards be supplemented by large ones to confirm the most practically valuable conclusions drawn from previous experiments on a small scale. *Nearly seventy acres of one acre plots have for this purpose been this year included in our experiments in different parts of the island.**

No single Central experiment station, however well equipped, could grapple satisfactorily with the problems that require to be answered under the varying conditions of soil, climate and agricultural treatment that obtain upon the estates and I am convinced that there is only one way of satisfactorily and conclusively dealing with those problems, and that is upon the estates themselves.

The study of the varying periods of growth of different varieties, and of the possibility of improving the cane by 'chemical selection' of the seed cane, are receiving careful

* Seedling experiments on an estate scale were announced on April 12, 1901, at a meeting of the Barbados Agricultural Society (see *Planters' Journal* for March 1901, p. 74) and in the pamphlet on *Seedling and other Canes in Barbados, 1901*, (pp. 36-7) published December 6, 1901.

attention and the results will be duly reported upon. Large numbers of samples of juice from the estate mills obtained from the different varieties under cultivation are analysed each year at the Government laboratory and the results which are included in the report serve to show the variations in composition from one end of the crop season to the other as well as to check the results of the samples of juice from the same varieties crushed in the laboratory mill.

The Hon'ble F. J. CLARKE (Barbados): I should like to express on behalf of the planters of Barbados their appreciation of the work being done by the Imperial Department of Agriculture to further the interests of their industry. We hope that as one result of the experiments with seedling canes the Department will be able in time to give us a 'good all-round cane,' of much greater merit than the varieties at present under cultivation, and from the experiments with manures, to teach us how to obtain the largest possible returns from the particular variety cultivated. The ultimate verdict with regard to the adoption of any cane or any method of manurial treatment must rest with the planter. It is unnecessary for the Department to try to create fame for a particular cane. Any variety will be tried by the planter, and when he has cultivated it on a sufficiently large scale to convince him that it is better than the canes he has been growing, he will adopt it. This point was well brought out by Professor d'Albuquerque's reference to the Burke cane. That cane did so well at Dodds that Mr. J. R. Bovell, then in charge of the Station, advised planters to give it a trial. When planted however on a large scale it was found to be inferior to the canes then under cultivation. When a cane is found better than those now cultivated and the planters have satisfied themselves that it is better, there will be no difficulty in getting them to grow it extensively.

The Hon'ble G. T. FENWICK (Trinidad): It gave me great pleasure to learn from the President and from Professor d'Albuquerque of the perfection to which the organisation for propagating, selecting and cultivating, up to a certain point, new varieties of seedling canes has been brought. I am of opinion that to be of practical use to sugar planters, the experimental cultivation must not stop at one acre plots, but be continued on such a scale as to justify them in adopting new varieties for extensive planting on estates. The canes should be submitted, if possible, to the tests of cultivation on a much larger scale, ten, twenty-five, or even, in the case of those which have successfully passed the one acre test, fifty acre plots.

The tables of Mean Results published in the pamphlet on *Seedling and other Canes at Barbados, 1901*, apply of course to Barbados alone. If they were applied to other West Indian Colonies such as Trinidad and British Guiana they would be seriously misleading. In these last mentioned Colonies the Bourbon which is so far their standard cane, gives on an average not only considerably more than thirteen tons per acre but more than is recorded for the best of the seedlings under experiment. This shows the Bourbon cane to be in much worse case in Barbados than in other West Indian islands.

The PRESIDENT: Mr. Fenwick has somewhat misunderstood the intention in issuing the pamphlet on the Barbados experiments. It was never intended as a guide to planters in Trinidad as the conditions there are so different. I should have liked to have seen before us, to-day, a similar report on experiments at Trinidad. There are officers in charge of experiments in that Colony, but there is no report. We have also no reports from British Guiana where Imperial funds have been expended in carrying on experiments during the last three years. The results under one set of conditions cannot, possibly be applied to an entirely different set of conditions. I would, especially, urge that the reports of results obtained, say at Barbados, the Leeward Islands and Jamaica be regarded as applicable, only, to the circumstances of those Colonies. Similarly in estimating the value of certain canes, a cane suited to Barbados is not, necessarily, suited to Trinidad and Demerara. Canes B. 147, D. 95 and B. 208 are evidently capable of yielding the best results, only under certain favourable circumstances. If these favourable circumstances are found not to exist in a Colony it is useless to start the cultivation of these canes on a large scale.

Prof. J. B. HARRISON (British Guiana): Experiments conducted in British Guiana, on a small scale with B. 147, confirm some of the results obtained in Barbados.

Mr. W. D. SHEPHERD (Barbados): I agree with Mr. Fenwick that the yields of certain varieties of cane used as the basis of comparison in the tables of the pamphlet (*Seedling and other Canes at Barbados, 1901.*) are very low. 20·9 tons of canes per acre, mentioned on page 11, seems a very low return for White Transparent cane in Barbados, just as 13·17 tons appears to Mr. Fenwick a poor yield for Bourbon cane in Trinidad, where Bourbon is still successfully grown. It is well known to planters that a higher yield than twenty tons per acre is possible, and indeed frequent in estate practice, and it seems strange, to their perhaps unscientific minds, that they should be recommended to plant other varieties of cane which give no larger actual returns than they can get from White Transparent. For some reason or other the *plot return* of White Transparent is low and disappointing, and causes other varieties to appear superior. Mr. Fenwick has also expressed his opinion that it would be more convincing and satisfactory if the experiments recorded had been carried out on a larger scale. I am sure that all planters in Barbados who take any interest in these experiments heartily agree with Mr. Fenwick. It is felt that the very large amount of useful work so vigorously carried on by the Department of Agriculture would be of much greater help to, and much better appreciated by, agriculturists if it were, so to speak, collected at one Central station. The benefits to accrue from such a station are obvious and numerous. The small plots scattered over the island, without any Central station work to compare with and control results have been praised, explained and excused by Professor d'Albuquerque, but the advantages of stations as in Louisiana, the Sandwich Islands and elsewhere are too well known and proved to necessitate mention. Their Reports are very useful to us and the general principles established are

capable of local application. A Central station would moreover be of great benefit in providing a place for training men —not boys—as agriculturists. The Brunswick Station in Germany and the Louisiana Station have both done very telling work in training men to undertake skilled agriculture. The planter reads in the report on cane seedlings for 1901 that B. 208 gave an estimated return of twenty-six tons of cane per acre. He calculates and finds twenty-six tons to be 58,240lb. but he notices also that 100lb. only of canes selected from a small plot of thirty holes have been weighed and tested to supply the data for the given result.* Again in the Report for 1900 (page 22) it is stated, concerning B. 147, that 'by using an indicator such as phenolphthalein in tempering the liquor a marketable muscovado sugar should in every case be secured. When the planter in actual boiling-house work is finding it very hard to get anything like good muscovado sugar and is at his wit's end for fuel to boil the juice, he is constrained to remark that it is far easier to make sugar in a laboratory with pencil and paper than in a boiling house. It is worthy of notice that, possibly owing to recent practical experience, the remark quoted above has been omitted from this year's Report and B. 147 is there almost discredited as a muscovado sugar-cane. At a Central station such practical work would be done before the planter has had to do it.

Again in the Report for 1901 it would appear that B. 208 gave 26·30 tons of canes and 7,330lb of saccharose, equal at 80 per cent. to 5,864lb. or about three hogsheads of muscovado sugar. This would indicate that 8¾ tons of canes made one hogshead of sugar. The planter does not get such results.

Professor d'Albuquerque has stated that the Burke cane was first grown at Dodds and then largely planted and afterwards given up by planters, and that if this cane had been experimented with in plots as in the case of B. 147, the great disappointment would not have accrued. I am sure that there has been equally as much disappointment in regard to B. 147 as to the Burke seedling—and probably more money spent in planting the former than the latter. I see no way in which Dodds station was inferior in its method or to blame for the results of the Burke.

In connexion with the manurial experiments it seems to me that forty tons of manure per acre of the quality indicated in the experiments is a very large dressing to start with before adding artificial manures and is a larger quantity than is applied in practice here.

In conclusion, I would state that I feel sure the planters of Barbados recognize and appreciate the earnest and extensive work being carried on in all branches of the Department and are convinced that great good will eventually be gained both in respect of our methods and practice as well as in pointing to the need for more skilful work.

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* The experiment plots consisted of 100 stools, and thirty stools of canes were actually cut and weighed. A sample of about 105lb weight was then taken by a mechanical method, which has been proved to secure a representative sample, and of this 100lb were crushed and tested. See Pamphlet 13, referred to above, pp. 2-4. (ED. W. I. B.)

The PRESIDENT: The remarks that have fallen from Mr. Shepherd in reference to a Central station have often been made before, and as often, shown to be impracticable. There are already three Central experiment stations in this island supported by the Imperial Government, as also manurial and local stations. Any station required beyond these would have to be provided from local funds. When Mr. Shepherd is in a position to assure us that the planters in Barbados are prepared to support a Central station on the lines he suggests (costing probably £3,000 to £5,000 annually) the matter would assume a definite form—at present it is purely visionary.

Professor D'ALBUQUERQUE (Barbados): Before this discussion is taken up by delegates from other Colonies I would like very briefly to reply to one or two of the statements and criticisms of Mr. Shepherd.

We have taken as our standard the White Transparent cane, because it is the variety most largely grown in Barbados: and we have compared our seedling results not with returns obtained from exceptionally favourable fields, nor from exceptionally unfavourable fields, but from the fields where the White Transparent grew side by side with the seedlings themselves; that is, from fields in several parts of the island. I do not see therefore that the instances cited by Mr. Shepherd, which have become fixed in his mind because they are exceptionally favourable instances, where fields have given yields exceeding 2½ tons of sugar per acre in any way diminish the value of our standard. The average yield of sugar in Barbados, plants and ratoons is 1·4 tons per acre: the White Transparent upon the experiment fields gave 2·5 tons per acre; this we adopted as our standard and in doing so we certainly cannot be accused of adopting an inferior standard or one likely to increase the apparent value of any seedling variety.

Mr. Shepherd appears to question the correctness of our statement that forty tons of farmyard manure per acre was applied to one manurial experiment field. I can only say that a proportion of the baskets of manure were weighed under the supervision of officers of the Department and that I know of cases where more than forty tons of farmyard manure is applied.

Mr. Shepherd contends that our efforts are wasted because they are scattered over different parts of the island instead of being collected at one official experiment station. There is however apparently a unanimous opinion in the West Indies in favour of our method of working, because it is the plan adopted in every Colony where experiments of any importance are being carried out. The plan we work on is the plan adopted in Java where the 'experiment stations' really consist of laboratories for the staff who carry out their agricultural work in different parts of that island on land lent by the proprietors of estates. Indeed we are better off for we possess an experiment station with a moderate area of land at Dodds. Anyone who has studied the Java work knows well that it compares favourably with scientific agricultural work in any part of the world. Mr. Shepherd has cited the Sandwich Islands as a pattern. I am

under the impression that the experiment station at Hawaii where Dr. Maxwell carried out the work that has attracted so much attention, consisted of an area of land very much smaller than that attached to Dodds.

The Burke cane, in consequence of the favourable results at Dodds and one neighbouring estate, was cultivated by planters all over the island and turned out a failure. It has remained a success at the estate alluded to and a failure nearly everywhere else. Had the Burke cane been cultivated at local experiment stations its real value would have been ascertained and it would never have been extended over the island, and money would have been saved to the planters. No Central station could possibly effect this result. B. 147 is being cultivated at all the local stations and if planters waited for the results of a reasonable experimental period before they cultivate it on a large scale they would find out what its value is and where it can be grown with advantage. The average results at the local stations very closely agree with those obtained on a large scale on the estates where this variety has been cultivated, and this shows that the results at the local stations can be accepted as a valuable indication of what may be expected on the estates themselves. This indication requires confirmation in the same localities on an agricultural scale of one to five acres, and that provision is being made for such confirmatory experiments is foreshadowed in my opening remarks.

LEEWARD ISLANDS.

The Hon'ble FRANCIS WATTS (Leeward Islands): In speaking on this subject, I shall have to repeat a good deal of what I have said on previous occasions. The Leeward Islands have not a large equipment, and the number of officers is rather limited. As a consequence we have not yet succeeded in raising new seedling canes, but our experiments have been conducted on selected varieties of canes obtained from other places. Our work thus begins in the middle stage indicated by Professor d'Albuquerque. We have cultivated on small plots a limited number of selected canes. From the reports of the results obtained on these small plots the planters are enabled to select canes for trial on a larger scale, and these larger plots of from one to five acres, supplement in a natural manner the small experiments. Facilities are offered to the planters to enable them to obtain analyses of the juice from their plots so as to secure all the information possible. Working in this way there has been established a useful mode of transition from the small plot to the ordinary field of the plantation; this method appears to meet the requirements of the Leeward Islands, and I see no reason to advocate any change at this juncture.

The experiments thus carried on have as their chief object the finding of canes which will withstand the attacks of rind fungus and other diseases. The Bourbon cane suffered so severely that about the year 1894 there was some fear that the sugar industry might be ruined by disease. Fortunately by

that time the experiment work had so far progressed that planters were enabled to see, at the Station, healthy varieties growing side by side with diseased Bourbon canes. The lesson was not thrown away and in a short time the Bourbon was displaced by varieties selected from the Station. The opinion had been expressed that the liability to disease on the part of the Bourbon was transient, and that after a time it might recover. That, however, has not been our experience: on several estates trial plots of Bourbon canes of four or five acres each, have been cultivated. In all cases the plant canes have been badly diseased, but in some instances the ratoons were only slightly attacked. At any rate we were justified in our opinion that at present it would not be safe to return to extensive planting of Bourbon cane. The experiments in the Leeward Islands are thus devoted to finding the best cane to replace the Bourbon rather than to discovering a richer cane than the Bourbon when healthy.

CANE B. 147.

A good deal had been said about the seedling cane B. 147. My experience is that when the cane is ripe the glucose ratio is low; the cane appears to be a late ripener. This cane is being cautiously introduced into the Leeward Islands and so far it appears to give promising results. It is a difficult cane to establish and that may account for the poor results in some instances. I certainly deprecate strong expressions of opinion as to the value of the cane until it has been cultivated on a moderate scale under a variety of conditions. What I dread, as I have stated at a previous Conference, is the tendency of the planters to rush. When any variety is favourably reported upon there is a demand for plants of that kind, and a tendency to plant it too largely: should the variety prove unsuitable for the places where it is planted considerable disappointment follows. It is necessary that any variety newly introduced into a district be tried on plots of from four to five acres, from the results so obtained planters will soon learn how far the cane in question suits their needs.

MANURIAL EXPERIMENTS.

With regard to manurial experiments I consider it a singular thing that we have to-day a statement put forward with a great deal of confidence, which, when made by me some years ago, was received with a good deal of incredulity. The statement in question is that experiments have shown that no increased monetary return is obtained from the use of phosphates in the shape of artificial manure, when pen manure is also used. That the cane requires phosphates in fairly definite proportions is settled. But where we can get pen manure,—and in Antigua the pen manure is well made, it is not a matter of carting the mould from one field to another--where we can get pen manure well prepared, nothing more is wanted for plant canes. If a field is so situated that it is difficult to give it pen manure, but if at the same time the soil is maintained in good condition by any means, such as the use of green dressing, then

the application of artificial manures to the field will be beneficial. I would reiterate that, if, in the Leeward Islands, sufficient pen manure can be obtained, there is no need for artificial manure for plant canes, and further that you cannot go on indefinitely with artificial manure without the aid of pen manure. These remarks do not necessarily apply to other places, but they are confirmatory of what has been said in reference to Barbados.

For the manuring of ratoons the use of about forty pounds of nitrogen per acre in the form of sulphate of ammonia or nitrate of soda is beneficial and necessary. Additional amounts do not repay the planters. The reports of the experiments both with varieties of canes and with manures have been published in great detail,* and copies of these reports have been sent to all interested in the work. In conclusion I am glad to be able to state that in the Leeward Islands the Department has very cordial allies in the planters, and I feel that we are working on safe and sound lines.

The Hon'ble C. A. SHAND (Antigua): I thoroughly endorse all that has been stated by Mr. Watts with reference to the breakdown of the Bourbon cane in Antigua about 1894. Several planters still have some faith in the Bourbon, and endeavour to grow it on small acreages, but I am sorry to say that, however healthy it may look up to a certain point, as soon as the canes begin to mature and to get sweet, disease appears and the whole field looks as if fire had passed over it.

Both before and since the creation of the Imperial Department of Agriculture the planters have endeavoured to work in harmony with the scientific authorities. The advent of the Department has enable the experiments to be extended. This is fortunate because the special difficulties of soil and climate in Antigua necessitate trials in the various districts of the island. We have not yet attained the golden era, but we feel that we are on the high road to success. Speaking as the mouthpiece of the body of planters in Antigua who have selected me as their delegate I reciprocate all the remarks which have fallen from Mr. Watts, not only with regard to the *entente cordiale* which exists between the planting body and the Agricultural Department as a whole, but also between the planters and Mr. Watts individually. We look upon Mr. Watts as the life-boat which has saved the ship of Antigua at her critical stage of existence, and anything that we can do to promote the interest and advance the work of the Imperial Department of Agriculture, depend upon it we will do.

TRINIDAD.

Mr. J. H. HART (Trinidad): The experiments in Trinidad have been conducted on the lines of the last report, issued in

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**Sugar-cane Experiments in the Leeward Islands, 1900-1901.*
Part I. Experiments with varieties of Sugar-cane.
Part II. Manurial Experiments.
A summary of the above reports is given in Number 12 of the Pamphlet Series of the Department of Agriculture entitled *Seedling and other Canes in the Leeward Islands, 1900-1901.*

1900. The reports for the present year are in preparation, and I may say from my knowledge of their contents, that they confirm the results obtained at Barbados. Canes B. 147 and B. 208 were introduced into Trinidad with several others some years ago. On the first season's trial B. 208 was superior to B. 147. This year's returns show a similar result.

The sugar-cane experiment station at Trinidad is very small, only two acres in extent and contains 116 seedling varieties raised in the island or imported from other Colonies. Up to the present only Demerara and Barbados canes have been distributed to planters. I suggested at the last Conference that canes should not be sent out from the experiment stations until they had been under trial for at least five years. This period has now been passed through by a few varieties at our station and we intend to distribute them to planters as having undergone a satisfactory trial. Trinidad is very anxious to have a Central experiment station, and a proposal, I believe, has been submitted to the local Government for its establishment. I fully agree with the value of extended trials and would make the plots as large as possible, up to 100 acres. In Trinidad we have adopted the principle of giving open trials on small plots (twenty or forty to the acre) for several years in succession before experimenting on ten or twenty acre plots. Last year 60,000 plants selected from the best varieties were distributed among planters for trial on their estates. On the question of manurial experiments I can confirm Professor d'Albuquerque's remarks with regard to the use of potash. Our land at St. Clair Station seems to derive more benefit from the use of potash manures than from farmyard manures.

BRITISH GUIANA.

Professor J. B. Harrison (British Guiana): Reference has been made to the absence of reports on sugar-cane experiments from British Guiana. I must explain that I have not been engaged solely on agricultural matters during the last ten years. It has been necessary for me to do much travelling in the interior of the Colony, and to report on the geology, etc, of the country, and I have issued seven or eight reports during the last two years. Then, again, the experiment station is in a state of transition. We cannot take land and at once start its cultivation. It has to be drained and laid out; indeed we have been compelled to put in a drainage engine. The drought which set in last year almost destroyed the experiments. Owing to these various causes therefore it has been impossible to issue any detailed report of the work done. At the same time an enormous amount of matter for a report—most of which would be better left out—has accumulated and as soon as opportunity serves a report on the work will be prepared.

MANURIAL EXPERIMENTS.

With regard to manurial experiments, we have had twenty years' experience and the results are so consistent that it is not proposed to continue them with the Bourbon cane. Of course in

British Guiana, we have the advantage of level ground, and the differences met with in hilly countries do not exist. The experiments pointed to the value of nitrogen. the lesser importance of phosphates; and that where an average yield of less than about thirty-five tons of canes to the acre was obtained potash was not required. With regard to the varieties, further manurial experiments are necessary, and it is hoped that by investigating their manurial needs many of their objectionable characteristics may be modified. Experiments are also being made with a view to repeating the Java experiments of the cross-fertilisation of the standard varieties with other canes.

LARGE SCALE EXPERIMENTS.

The results of experiments with varieties on plots have been so dissimilar to those obtained in the field, that I have come to look on plot experiments with distrust. No trustworthy way has yet been found to get the returns of plot experiments to conform with the results of field cultivation. We have often had results from plots that were simply astonishing. On paper a cane might yield six tons to the acre, and yet we knew well that tried on a larger scale the yield would only be about one and a half tons. Apart from the tonnage of canes there are many points that can only be settled by experiments on a large scale. The defective milling qualities, and the deficiency of megass of some varieties cannot be discovered on small plots. At Albion plantation 1,000 acres are under cultivation in sugar-cane varieties, and changes in the building and construction to the extent of £5,000 have been rendered necessary to deal with these varieties, owing to their defective milling qualities and the deficiency of megass. With Mr. Jenman, I have agreed that the experiments could not be carried on in fairness to planters, looking to the great difference between results obtained in the laboratory from experiments on small plots, and those obtained from cultivation of the varieties under ordinary conditions in the field, unless we could get the assistance of the planters so as to carry on experiments on a large scale and to advise them as to the characteristics of the canes thus raised. A Sub-committee of the Board of Agriculture consisting of the Hon'bles R. G. Duncan and B. H. Jones and Mr. F. J. Scard, Agricultural Attorney of the Colonial Company, with Mr. Jenman and myself as non-technical members to go into the results of the experiments, has been formed and has unanimously adopted the following resolution :—

Passed by the Sugar-cane Committee of the Board of Agriculture, British Guiana :—

That the results obtained by the experiments on the small plots which it is necessary to employ during the earlier stages of the inquiries into the relative values of new varieties of seedling sugar-canes cannot be received as indicating those consequently obtainable on the commercial and economic scale, the conditions of which in important respects are necessarily materially different.

For decision as to the economic value of a new variety of

sugar-cane it is essential that results be recorded as obtained on canes grown on estates' scale, and treated under factory conditions.

We have in British Guiana, at the present time, 2,700 acres under strict chemical control, as perfect as exists in any part of the world. Mr. Seard has 1,500 acres in varieties, and at all the plantations (of which they are now only fifty-two, owing to amalgamations), experiments with seedling and other varieties are being carried on as a continuation of the experiments with varieties begun in small plots in the Botanic Garden, and, after careful selection, gradually extended to larger areas. I hope within the next eighteen months to have the figures of the results so obtained.

In speaking as I have with regard to the unreliability of the results obtained from small plots, it should be clearly understood that I am not running down small plots. I advocated their uses many years before any other official chemist at present in the West Indies had come out here. Small plots are necessary, but they are necessary evils because persons took the results obtained on them and worked them out as though obtainable on a large scale; When they proceeded to actually plant on a large area and got different results, they became distrustful of all results recorded from the small plots. The sooner the aid of the planters can be enlisted in carrying out experiments in practical work, whether the system of manufacture was the open tayche and muscovado, or the factory and vacuum pan, the sooner shall we be able to attain the results desired. The varieties most generally under cultivation in Demerara, are D. 145, 109, 95, 74, and B. 147. These are all largely planted. B. 147 has given similar results on small plots in British Guiana to those obtained in Barbados, and a curious thing was that in Demerara it ratooned in a most wonderful way. There were two groups or classes of these varieties: those that give heavy crops of cane per acre - some yield as much as seventy tons of cane, but unfortunately nothing like that proportion of sugar, and others that give a low crop of canes but a good proportion of sugar. Possibly those varieties that produce heavy crops of canes are suited to poor lands. D. 74 and D. 95 have done well in Louisiana. In British Guiana they yield small crops of canes but rich juice. As soon as I can get the results of the experiments together, they shall be forwarded to the Department of Agriculture.

The PRESIDENT: The discussion, to-day, has been a valuable one. If we continue our experiments and, regularly, publish the results we shall certainly benefit the sugar industries in these Colonies. While I admit that larger areas are necessary for the best results, we must also carry on the small-plot system in special cases. In addition to supervising the experiment stations under scientific control, it is important that the officers-in-charge should be in touch with the planters, carefully observe the canes while growing, analyze the juice, and be thoroughly conversant with the circumstances of the industry. The laboratory work should be in full sympathy and harmonize with the estate work. This, I believe, is fully recognised

already by the official chemists in the West Indies. It is a most hopeful sign when all the leading authorities connected with sugar-cane growing in these Colonies join, so heartily, in efforts to improve the industry and to place it on a sound scientific basis. The reference I have, already, made to the absence of regular official reports on the sugar-cane experiments carried on at Trinidad and British Guiana will, I hope, result in our obtaining such reports in time to be printed and circulated before the annual Conferences. There can be no doubt as to the earnestness and zeal of those who are in charge of the experiments, and we have very tangible evidence of that in the excellent papers and in the discussion to day.

THE PROSPECTS OF THE SUGAR INDUSTRY IN JAMAICA.

BY HERBERT H. COUSINS, M.A., F.C.S.

Government Analyst and Agricultural Chemist, Jamaica, in Chemical charge of Sugar-cane experiments.

A century ago the seaboard of Jamaica was girdled with sugar estates, even places far from the sea and involving most laborious cartage were able to produce sugar and rum profitably. Lands and situations far from suitable for cane cultivation were brought into use, under the stimulus of high prices and limited production.

THE PRESENT DIMENSIONS OF THE INDUSTRY.

With the steady growth of the world's competition in sugar production, the full brunt of which has been borne by the British West Indies, a very different allocation of sugar areas now obtains in Jamaica. The seaboard girdle of sugar estates has vanished—on the north side, St. Mary and Portland have entirely abandoned the sugar-cane for the banana. St. Andrew boasts but one estate, while the once famous sugar parish of St. Catherine has but 1,000 acres in cultivation. The following Table will give a general idea of the present dimensions of the sugar industry of Jamaica as represented by estates of appreciable size.

TABLE I.

SUGAR ESTATES IN JAMAICA 1901. *

District.	Total area in canes. Acres.	No. of Estates.	Average area canes. Acres.	Proportion of estates under canes.
(1.) Westmoreland ... ... / Hanover .. ... / St. Elizabeth	7,163	41	174	$\frac{1}{16}$
(2.) St. James ... ... / Trelawny ... ... / St. Ann	8,737	51	171	$\frac{1}{8}$
(3.) Clarendon ... ... (Vere)	4,301	18	228	$\frac{1}{10}$
(4.) St. Catherine	1,164	5	233	$\frac{1}{14}$
(5.) St. Andrew ... ... / St. Thomas	966	6	161	$\frac{1}{11}$
Total	22,331	121	184	$\frac{1}{9}$

It will be seen that some 121 estates, representing 22,231 acres of canes, now exist. These average 184 acres each of cane cultivation—representing but one-ninth of the total area of the estates.

YIELD OF PRODUCE.

The following figures (Table II) give the return of sugar

* This Table does not include small cultivators' areas of canes. In 1898-9 the total acreage of canes in Jamaica was officially returned at 26,121 acres.

and rum for the crop of 1899, which on the whole was a favourable season.

TABLE II.

YIELD OF SUGAR AND RUM FOR CROP OF 1899.

District.	Acres.	Sugar in hogsheads.	Rum in puncheons.	Sugar per acre. Hogsheads.	Rum per acre. Puncheons.
(1.) Westmoreland ... ... Hanover ... ... St. Elizabeth	7,163	7,286	5,289	1·00	0·74
(2.) St. James ... ... Trelawny ... ... St. Ann	8,737	7,869	5,616	0·90	0·64
(3.) Clarendon ... ... (Vere)	4,301	6,020	3,670	1·40	0·85
(4.) St. Catherine	1,164	1,471	666	1·26	0·57
(5.) St. Andrew ... ... St. Thomas	966	1,052	688	1·09	0·71
Total	22,331	23,698	15,929	1·06	0·71

The average yield for Jamaica in a favourable year thus amounts to about a ton of sugar and three-quarters of a puncheon of rum per acre. These figures sum up the commercial aspect of the sugar industry as at present carried on in Jamaica. I now propose to consider each district *seriatim*, noting the special conditions and circumstances obtaining and suggesting some obvious means of improving the sugar prospects in each case.

Westmoreland, Hanover and St. Elizabeth.

This area should be marked out as one particularly favoured by nature for sugar-production. Although as regards the crop of 1899 it was surpassed by the Vere district in yield per acre, an examination of the crop returns over a series of years would show that this district is far more uniform and consistent in production, and receives a more regular and more plentiful rainfall.

The soils vary greatly, both in consistency and in natural fertility. Some of the Westmoreland estates have to deal with decidedly poor lands, and high farming is necessary to get a reasonable stand of canes every year; drainage is also a practical difficulty in some instances. Other estates, however, rejoice in extremely fertile soil and can reap large crops of first-rate cane at a low cost of production per ton. From the figures published by Mr. P. Greg in the *Journal of the Jamaica Agricultural Society* for 1900, it would appear that the cost of growing canes in this district on two average estates was a little less than 6s. per ton delivered at the mill. Other planters have given me figures slightly lower that this, but the basis of calculation was not the weigh-bridge as in Mr. Greg's estimate.

A visitor to this district is struck by the signs of healthy development already appearing. Young men of brains and enterprise are here working away with faith in the future and confidence in the soundness of sugar under conditions of efficiency as regards crushing and manufacture.

It is gratifying to hear of a group of estates having freed itself of an enormous debt by less than a decade of thrifty and intelligent management, and of the establishment of a centralised factory.

Considerable interest has been shown by sugar managers in Jamaica in the new plant of machinery at Cornwall estate. Mr. W. Farquharson sends me the following figures as to crop obtained there.

Acres cut 172, canes 3,359 tons, average density 90° B., tons of sugar 261, puncheons of rum 87 (10,466 gallons), tons of cane per ton of sugar 12·8, tons of cane per 'ton and puncheon' 9·6. The mills expressed 78 per cent. from plants and first ratoons and 74 per cent. from second ratoons. This is an estate where cane is grown under difficulties, and yet has yielded an addition of quite 50 per cent. by the introduction of double crushing and evaporation in vacuo.

At Holland estate in St. Elizabeth is to be found a modern mill which gives an expression almost, if not quite, equal to the double crushing plant at Cornwall.

Efficient milling is the first watchword of the progressive planter in Jamaica. A conservative estimate would place the initial losses at 30 per cent. in the majority of Jamaica sugar estates. It would also seem that one good mill is better than two inferior mills crushing tandem.

Rum is the vital feature of the prosperity of several estates in this district. Some 'German rums' of good reputation are

produced and this has deterred several planters from installing a modern outfit for evaporation *in vacuo*. It is difficult to get up an esoteric enthusiasm for 'German rum' since it is associated with mediaeval sugar management, is steeped in rule of thumb and at best is but an assistant to adulteration. Yet it pays, and in some cases is the sole mainstay of the estate. Looking at the matter broadly, I think it is an undoubted fact that 'German rum' has prejudiced the sale-value and public estimation of Jamaica rum. It also makes it impossible to protect the valuable asset of the name possessed by Jamaica rum, since certain Jamaica rums are undrinkable as such and serve solely to flavour multiple puncheons of continental potato spirit. I was much struck on going through some of the stillhouses in this and other districts to find the great variation in the yield of rum obtained from successive fermentations apparently carried out under identical conditions. If 'rums can be improved from 2*s*. to 6*s*. per gallon' (H. S. Hoskins) the yield of ordinary 'common clean' could certainly be increased 25 per cent. in most still-houses by ensuring uniformity of fermentation. This would mean a gain of £30,000 to £40,000 a year in the island's production of rum. It is to be hoped that it may soon be possible to apply to Jamaica rum those methods which have played so important a part in the modern breweries and distilleries of Britain and the Continent of Europe.

Central factories are now being talked of here and would undoubtedly be a success. Mr. Greg has shown that an estate would be better off selling cane to a factory at 10*s*. per ton than yearly facing the troubles and risks of its own muscovado process. A profit of 4*s*. per ton would be such a sufficient agricultural return that enormous crops would be raised should a factory be started in any suitable neighbourhood. At Retreat Mr. W. Farquharson is doing this on a modest scale for the coming crop. A centralised factory is to be erected at Appleton estate and it is hoped that 1,000 acres will be planted here and the crop dealt with by a compact and well organised modern plant. Holland, a former property of the Gladstone family, is an estate that is making a bold bid for success; 1,500 acres of flat, alluvial land are here available. Heroic methods in the way of trenches have worked wonders and we have not seen finer canes on any estate in the island.

Seedling canes have attracted a good deal of notice in this district. The results obtained have been very encouraging to the eye, in several instances, but no exact figures are at present available. Seedling trials in this district have been arranged by the Board of Agriculture and it is hoped that the results will lead us in the desired direction.

Fertilisers are little used at present. Trials are being made on two typical soils, and opinions as to the virtues of cowpeas vary, but most planters are of the opinion that they afford an excellent means of reinforcing the fertility of their cane lands. Experiments to test this are on hand. The use of American ploughs and cultivators is extending and there is a brisk demand for half-bred Indian cattle for draught purposes. A development of the sugar industry would immediately restore

the shattered prospects of the penkeepers, and there has been a good deal of enterprise shown lately in the purchase of pure bred Indian stock for breeding purposes.

General Conclusions. To improve the industry in this district the following points demand attention:

1. The establishment of 'central' or, perhaps more practicable, of 'centralised' factories.

2. Improved milling on individual estates and the abolition of the muscovado process where German rum is not a consideration.

3. A reorganisation of the still-house routine. Chemical control of the liquor and the use of selected yeasts.

4. Improved drainage, more thorough cultivation, attention to the needs for green dressings and fertilisers.

5. Careful and systematic trials of seedling canes.

6. Employment of trained book-keepers capable of carrying out a chemical control for ordinary factory purposes.

St. James, Trelawny, St. Ann's.

These parishes are classed together as having a certain predominant feature in common, namely, a deficient rainfall and a low average yield of canes. Many estates ratoon continuously and boast cane-fields which have not been replanted for over half a century. Despite the low yield of cane, the returns of sugar and rum are often remarkably good. Rum has been the chief mainstay in most cases, and the following table giving the results of the two last crops at five estates belonging to the Hon'ble H. Sewell has been very kindly prepared and placed at my disposal by H. S. Hoskins, Esq, the attorney-in-charge. The following statement by Mr. Hoskins will carry great weight as coming from the most responsible sugar manager in the parish of Trelawny :—

'I now forward the statistics of five sugar estates in this parish as requested. Hyde, Vale Royal and Cambridge are planting and ratooning estates, Steelfield and Braco ratooning only.

'We have no means of weighing our canes and calculate a load of canes giving 100 gallons of cane juice as being equal to four-fifths of a ton.

'With regard to the sugar prospects of this parish, unless prices for produce improve considerably, cane cultivation will have to be abandoned. Last a/c sales of sugar in New York at 3 $\frac{5}{16}$ cents showed net proceeds of £5. 10. 10 per ton! Common rums net £5 per pshn. less than last year and fine rums have not done as well. Such prices *on top* of a dry year and small crops spell heavy loss. Better and more powerful machinery for crushing the cane is sadly needed, and canes that will not be so seriously affected by dry weather. What variety is now being planted in Antigua and is reported to give fair crops yearly? *

'Our tonnage of canes per acre is very small, but as you

* Mr. Hoskins is now carrying out a systematic trial of selected seedlings with the assistance of the Board of Agriculture.

will see from the returns (Table II) the other parishes are not doing much better.

'Where is our cultivation at fault and how can it be improved? This has worried me a good deal. In 1900-1 the estates cut more plant canes than ever. the land had been thoroughly forked and fertilised—dry weather ensued and the returns could not have been less from old ratoons!

'Trenching and drainage have been much neglected, in fact almost ignored. The rule in Louisiana appears to be that the bottom of the trench should be 18 inches below the bottom of the cane hole. I recently gave instructions to dig down and round a cane stool and to wash the dirt out of the roots. The roots were found to spread laterally until they met and interlaced with those planted 4ft. 6 in. on each side and to descend from four to six feet. The roots simply packed the soil. How deep is it necessary to drain? Estates in Trelawny are too small and can not be amalgamated,

'Mr. Sewell has to pay 11 overseers, 25 book-keepers, 11 engineers, 11 head men, to do work that 1 overseer, 5 book-keepers, 1 engineer, 1 head man do at Money Musk (Vere) for Colonel Ward.

'The latter works, I was informed,190 head horned stock and 90 mules. Mr. Sewell having no tramways, has to keep 1,720 head horned stock and 630 mules.

'Money Musk does not spend a penny for carrying green or dry trash or for sunning and drying it. Mr. Sewell's estates employ over 100 men and women and 120 children weekly on this work alone. And the Money Musk mills express probably 70 per cent., the Trelawny mill 55 per cent., of the weight of cane in juice. As you will notice from the statistics (Table III) it is the prices obtained for rums that have kept the estates going. Sugar is a secondary consideration and receives very little attention and is sacrificed for rum to a very large extent.

'Rums can be improved from 2s. to 6s. a gallon, but there is no certainty about the manufacture at present: the same process does not always give the same results,—the materials that go to make it differing with different seasons and the quality of the canes.

'I should like to see £10,000 deducted from the education grant and devoted to Experiment stations and laboratories as in Hawaii and Louisiana.'

(Sgd.) H. S. HOSKINS.

TABLE III. STATISTICS FOR CROPS 1899 AND 1900 ON HYDE, VALE ROYAL, CAMBRIDGE, BRACO AND STEELFIELD ESTATES IN THE PARISH OF TRELAWNY.

	Hyde.		Vale Royal.		Cambridge.		Steelfield.		Braco.	
	1899.	1900.	1899.	1900.	1899.	1900.	1899.	1900.	1899.	1900.
Tons Sugar made	226	222	200	175	270	143	140	90½	172	105
Puncheons Rum made	151½	130	179	178	200	128	95	70	128	92
Average gallons Cane juice per ton Sugar	2,288	2,402	2,207	2,652	2,373	2,899	2,284	2,747	2,493	3,302
Average gallons Cane juice per Cask (Sugar and Rum) ...	1,434	1,488	1,252	1,434	1,373	1,529	1,438	1,548	1,507	1,760
Average tons canes per ton Sugar	18	19⅖	17⅗	21	19	23½	18½	22	20	26⅔
„ „ „ „ Cask (ton Sugar and puncheon Rum ..	11	11	9⅓	10	10½	12½	10⅞	12	11	14
Tons Canes per Acre . ..	19	13⅘	13⅗	14⅔	20	12	18¾	14	15⅔	12
Cultivation expense per ton Canes [A]	3 3½	3 11	3/1½	3 2½	1 8	3	1 2¼	2 0½	11¾d	2/1
	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.
Cost per acre for manuring canes	3 3 9	2 14 8	3 15 3	2 9 3	3 0 5	2 12 4	2 9 4	2 12 7	1 19 7	1 13 5
Cost per Cask for Labour [B] .	7 1 3	7 18 11	5 19 6	5 18 5	4 15 3	7 12 0	4 16 7	6 19 8	6 0 4	8 11 10
Cost per Cask for Labour and Contingencies [C]	13 2 1	14 11 1	11 17 0	12 7 8	8 13 0	14 14 0	9 8 2	13 19 8	9 9 5	15 9 6
Average net Proceeds for Ton Sugar	10 6 8	10 2 6	10 5 5	10 1 0½	10 14 6	10 2 1½	10 4 11	9 16 10	10 11 10	10 8 9
Average net Proceeds for Rum ...	13 0 7	16 1 8	19 3 0	20 11 11	13 5 10	17 13 4	9 4 5	11 17 5	15 3 0	16 3 8
Average Density of Juice ...	... ...	... ...	26	23	... ...	... ...	... ...	... ...	24	20

Variety of Cane most grown—Transparent and Ribbon or Striped.
Labour—Quality fair, supply good.
(A) *Cultivation, i.e.* Preparing land, forking and subsoiling, cane holes, cleaning and supplying, trashing.
(B) *Labour, i.e.* Cultivation, manuring, pastures, fences, manufacture, stock, tradesmen, barquidier, headmen, etc.
(C) *Labour and Contingencies, i.e.* Labour and salaries, machinery, stock, lumber, import duties, manure, supplies and miscellaneous.

Mr. Joseph Shore of St. James, as the representative of the Jamaica Agricultural Society at this Conference, will contribute a paper and I will leave all further consideration of the needs of this district to his superior knowledge and experience.

CLARENDON, (VERE).

The plains of Vere represent a magnificent stretch of level alluvial soil which is excellently adapted to the growth of the sugar-cane. The soil varies a good deal and from twenty-five samples which are being analysed in the Government Laboratory, I am already certain that it exhibits marked variation in mechanical composition although fairly uniform chemically. On the whole, the soil of this district tends to be stiff and the subsoil in many cases is quite impervious. A general lack of lime is also apparent. The local experiences of applying marl have been most satisfactory. The rainfall is very fickle—in some years being as low as thirty inches, while in 1886 as much as ninety inches were recorded. The total rainfall, however, is not the crucial factor but rather its distribution. In some years a prolonged drought has practically destroyed the crop. The Milk river is now being canalised to irrigate this district, and a means of ensuring regular crops seems within actual range of view. I would, however, urge the authorities most earnestly not to permit a single yard of irrigation water to be used until the estates have established an adequate system of drainage. The water-logged, fever-stricken plain of St. Catherine which was first irrigated, and is now after years of stagnation being drained in a half-hearted manner, will be entirely eclipsed by the agricultural and human disasters that would certainly follow the irrigation of the Vere estates *without drainage*. A firm stand in this matter is most vital. Moreover the drainage must be deep and thorough.

It is confidently to be expected that this district, rationally irrigated, will be a most productive sugar area. Great developments are to be expected, and Vere should stand out as the most efficient example of modern sugar production in the island.

The centralised factory of Colonel Ward, C.M.G., at Money Musk, where the canes from four contiguous estates are worked, is an object lesson of the splendid possibilities of sugar in this district. Critics might find fault with the economy of the methods of manufacture employed and suggest a more economical combination of machinery, but no one can deny the fact that Colonel Ward has built up a splendid industry by gradual and continuous improvements and that he produces sugar more cheaply than any other planter in the island. From the data given in Table IV, which was kindly prepared for me by Mr. J. Fox the energetic manager of this enterprise, it will be seen that the cost of growing canes on the estate including 150 acres of new land, which had to be cleared and stumped, was 1s. 1*d*. per ton of cane. To this must be added the charges for management, cutting and carting to the mill in order to compare this figure with the Westmoreland estimate already given. There is no doubt that the Money Musk canes cost decidedly less, although the actual

figures are not for publication. Tables V to X gives the rainfall and the yield of sugar and rum for this estate over a series of years. This is an instructive collection of figures as illustrating the effect of improved cultivation and methods of manufacture on the output of the estate, and has a very practical teaching for the generality of Jamaica sugar estates. Experiments on fertilisers and cane varieties are in progress. Basic slag was diagnosed as the most suitable phosphate for these soils.

Seedling canes are being tried somewhat largely, but it is very doubtful whether any variety at present grown is an improvement on the selected White Transparent generally cultivated in Jamaica. Irrigation may render possible the successful cultivation of D. 95 on the lighter soils and perhaps one or other of the selected Barbados seedlings on the heavier lands.

A well matured scheme for a Central factory has been brought forward, and it is to be hoped will soon become a reality of the success of the venture, under good management, there can be no doubt at all. The agricultural and local conditions are so eminently favourable and the irrigation will set a seal of certainty on the returns from perhaps the most fertile agricultural plain in Jamaica.

TABLE IV.

EXPENDITURE ON MONEY MUSK ESTATE FROM AUGUST 1, 1900 TO JULY 31, 1901.

Cane Cultivation.

	£	s.	d.
Preparing land this includes the cutting down, digging out stumps, and clearing of 150 acres of new land	437	17	4½
Ploughing	188	4	6
Lining land, and digging cane holes	150	17	1½
Procuring tops, carting and planting	386	16	10½
Carting and applying manure . ..	215	2	9
Trashing	378	10	6
Cleaning canes and turning trash	1,433	8	8
Lining, digging, and cleaning trenches ...	320	3	1½
Procuring tops and supplying canes ...	140	9	9
Hoe-moulding canes	267	11	1½
Plough-moulding canes	22	16	0
Harrowing land	6	12	0
Planting pease (for green dressing)	6	7	6
	£3,954.	17.	9½

21,129 trucks of canes carted (as per memorandum) for the crops. Each truck calculated at 1,800 lb. canes will give 19,389 tons, 7 cwts, 2 qrs. weight of canes, at a cost of 4*s.* 1*d.* per ton.

The 1901 Crop.—923 acres, 2 roods, 6 perches cultivated, made 1,525 tons, 2,240 lb. net, vacuum pan sugar, and 526 puncheons rum.

Rainfall in 1900—39 inches and 90 parts.

TRUCKS OF CANES CARTED ON MONEY MUSK ESTATE FOR CROP

1901.			1901.		
January	26	1,229	April	13	1,594
February	2	1,456	„	20	1,746
„	9	1,328	„	27	1,811
„	16	1,670	May	4	1,888
„	23	1,805	„	11	1,536
March	2	731	„	18	800
„	16	1,438	June	22	424
„	23	1,179			
„	30	1,776			24,129
April	4	1,418			

TABLE V.

MEMO OF RAINFALL, ACREAGE IN CULTIVATION, AND PRODUCE MADE ON MONEY MUSK AND KNIGHTS ESTATES FROM 1877 TO 1885.

Years.	Rainfall. Inches.	Parts.	Acreage. Acres.	Roods.	Perches.	Crops. Sugar. Tons.	Rum, Pbns.	Remarks.
1877	35	32	475	0	30	186	291	Sugar Potted in Hhds.
1878	69	88	610	2	1	389	286	„ „ „
1879	94	31	488	1	27	126	211¾	„ „ „
1880	29	63	316	2	30	308	144	„ „ „
1881	58	67	434	2	26	373	208	„ „ „
1882	32	89	479	1	27	666½	322	„ „ „
1883	24	99	178	0	37	415	228	„ „ „
1884	31	91	476	3	17	322	187	„ „ „
1885	41	43	360	0	20	223	190	Centrifugalized.

TABLE VI.

Memo of Rainfall, Acreage in Cultivation, and Produce made on Money Musk and Greenwich Estates from 1886 to 1891.

Years.	Rainfall.		Average.			Crops.		Remarks.
	Inches.	Parts.	Acres.	Roods.	Perches.	Sugar. Tons.	Rum. Puncheons.	
1886	97	1	228*	3	17	82¼	115½	Sugar Centrifugalized.
1887	59	33	194	0	31	561	650	,, ,,
1888	61	62	520	3	21	606½	611	,, ,,
1889	46	78	567	2	4	527½	534	,, ,,
1890	21	96	555	1	25	517	558	,, ,,
1891	55	71	491	1	16	171	223	,, ,,

*The actual acreage in cultivation for crop 1886, was 128 acres 3 roods 17 poles, but 200 acres were left as stand overs, on account of the flood.

TABLE VII.

Memo of Rainfall, Acreage in Cultivation and Produce made on Money Musk, Greenwich, Carlisle and Knights Estates from 1892 to 1901.

Years.	Rainfall.		Acreage.			Crops.		Remarks.
	Inches.	Parts.	Acres.	Roods.	Perches.	Sugar. Tons.	Rum. Puncheons.	
1892	32	74	679	2	29	809	873½	Sugar Centrifugalized.
1893	73	80	699	3	15	515½	474	,, ,,
1894	53	89	732	2	38	1051	988	,, ,,
1895	36	66	719	1	29	691½	665½	,, ,,
1896	39	31	702	1	33	625½	484½	,, ,,
1897	62	77	768	1	7	1232	479	,, ,,
1898	59	89	748	1	29	1359¼	364	
1899	37	81	757	3	15	1598¾	512	
1900	39	90	747	2	7	946	354	
1901	43	80	923	2	6	1525	526	

TABLE VIII.

MEMO OF RAINFALL, ACREAGE IN CULTIVATION AND PRODUCE MADE ON CARLISLE ESTATE FROM 1881 TO 1891.

Years.	Rainfall. Inches.	Rainfall. Parts.	Acreage. Acres.	Acreage. Roods.	Acreage. Perches.	Crops. Sugar. Tons.	Crops. Rum. Phns.	Remarks.
1881	54	90	169	0	0	123	74	
1882	37	32	189	2	0	283	152½	
1883	26	35	196	0	0	177	99¼	
1884	30	63	193	0	0	139½	76	
1885	63	85	191	0	0	113	83	
1886	90	6	156	0	0	77	55	Sugar potted in hogsheads.
1887	56	37	190	0	0	206	121¾	
1888	63	47	188	.	.	179	98	
1889	45	36	175	0	0	136	73	
1890	20	44	184	0	0	167	161	
1891	57	28	119	0	0	70½	13½	
1892	32	22	nil.	nil.	nil.	nil.	nil.	
1893	83	37	..	..	..	..	..	
1894	53	29	..	..	..	..	..	The crops from 1892 to date have been reaped at Money Musk.
1895	39	91	..	..	..	..	..	
1896	47	81	..	..	..	..	..	

TABLE IX.
RAINFALL ON CARLISLE ESTATE FROM 1884 TO 1896

YEARS.	1884		1885		1886		1887		1888		1889		1890		1891		1892		1893		1894		1895		1896	
Months.	Inches.	Parts.	Inches.	Parts.	Inches.	Parts.	Inches.	Parts.	Inches.	Parts.	Inches.	Parts.	Inches.	Parts.	Inches.	Parts.	Inches.	Parts.	Inches.	Parts.	Inches.	Parts.	Inches.	Parts.	Inches.	Parts.
January ..	1	20	2	30	2	95	2	89	5	6	2	33	...	...	...	59	1	70	2	10	...	...	...	50	...	74
February...	1	64	...	37	1	51	3	16	...	.	...	..	2	65	3	89	1	...	1	19	...	61	...	78	3	20
March ..	2	33	1	5	4	35	...	..	2	55	4	61	1	69	...	60	...	10	..	48	1	16	2	5	4	65
April ...	...	...	...	92	7	51	1	72	...	95	3	45	...		4	7	...	...	1	77	...	91	2	92	...	...
May ..	1	92	3	13	7	33	4	45	26	37	1	55	1	83	7	27	1	..	4	58	9	27	3	37	9	97
June ..	1	59	...	70	33	68	11	59	6	17	13	51	.	...	10	65	4	38	5	22	5	78	5	1	2	25
July ...	...	98	..	...	9	65	12	87	1	84	3	15	2	17	5	60	...	89	14	4	2	62	...	66	7	18
August ..	4	57	2	52	5	11	2	19	3	63	4	86	4	50	3	97	...	65	4	98	1	98	4	53	1	20
September..	4	11	2	61	3	6	4	75	10	86	4	34	..	50	1	23	..	81	13	70	1	2	3	78	8	43
October ...	8	5	3	22	11	29	9	58	3	10	5	77	2	55	14	96	17	16	8	83	20	11	12	35	3	88
November...	3	20	...	24	1	67	3	17	...	92	1	79	4	55	4	45	1	36	15	49	4	38	3	96	3	33
December...	1	4	17	97	1	95	...	...	2	2	...	...	...	...	..	...	3	17	10	99	5	15	...	...	2	98
	30	63	35	3	90	6	56	37	63	47	45	36	20	44	57	28	32	22	83	37	53	29	39	91	47	81

TABLE X.

RAINFALL ON MONEY MUSK ESTATE FROM 1884 TO 1896.

Years.	1884		1885		1886		1887		1888		1889		1890		1891		1892		1893		1894		1895		1896	
Months.	Inches.	Parts.	Inches.	Parts.	Inches.	Parts.	Inches.	Parts.	Inches.	Parts.	Inches.	Parts.	Inches.	Parts.	Inches.	Parts.	Inches.	Parts.	Inches.	Parts.	Inches.	Parts.	Inches.	Parts.	Inches.	Parts.
January ..	1	27	2	75	4	14	1	7		83	2	90	.	20		96	1	75	2	91		26	.	91	1	9
February ...	1	90	..	30	.	56	2	12	3	47		..	3	15	2	23	1	17	1	17		56		52	2	99
March .	2	48	2	30	4	70	.	10	2	45	4	61	1	72		35		16	1	13	1	43	1	1	1	79
April ...	nil.	nil.	...	90	7	.	2		1	77	4	33		29	5	31	.	2	1	68	2	2	2	18	...	25
May ..	2	15	4	70	5	57	4	76	24	90	1	68	2	31	9	90	1	1	1	57	9	8	3	87	7	80
June ..	1	30	1	10	31	89	10	76	6	40	13	21	.	.	9	35	3	81	3	59	6	91	5	4	2	2
July ..	...	77	..	...	10	51	12	87	1	65	3	72	2	44	5	66	...	70	12	1	3	..	1	5	6	38
August		10	2	30	5	80	..	95	3	18	1	30	4	49	3	68	.	85	5	69	2	54	5	17	.	55
September..	6	64	2	19	3	85	6	50	13	45	4	51	..	86		77	3	12	10	64	1	19	2	85	8	1
October .	10	90	4	99	11	30	11	67	4	52	5	14	.	15	12	17	14	67	8	52	18	81	10	87	3	32
November .	3	35	.	59	5	30	2	93	.	50	2	30	6	5	4	82	2	3	12	84	3	68	3	19	2	23
December...	1	45	19	51	2	30	...	...	1	50		5	...	.	.	15	3	12	9	2	4	41	..	...	2	88
	31	91	41	43	97	1	59	33	64	62	46	78	21	96	55	71	32	74	73	80	53	89	36	66	39	31

St. Catherine's.

The chief estates in this parish, at present, are Caymanas and Worthy Park. The former is a low-lying swamp to which the Government permitted the use of irrigation water without any practical provision for drainage. The results have been most lamentable as regards the health of the estate, and doubtless the yield of cane and the quality of the juice have been seriously prejudiced by the sodden state of the cane-pieces. Such a cane as D. 95 practically refuses to grow here, being poisoned by the stagnant water which often rises almost to the surface of the soil. Apart from this, Caymanas for some years was the leading estate of the island and it is still in the front rank.

Worthy Park is deserving of especial mention as owing its continuance as a sugar estate to the use of fertilisers as recommended to the owner by my predecessor, the Hon'ble Francis Watts. Recently two schemes for Central factories, on rather ambitious lines, have been put forward with a considerable weight of responsibility behind them. One purposes to establish an enormous sugar producing area in the plains of S. Catherine, using the railway as the distributing agent; the other is located in the fertile district of St. Thomas-in-the-Vale where enormous crops of cane per acre were formerly grown.

St. Andrew and St. Thomas.

The most interesting estate at present in this district is Albion in St. Thomas owned and managed by Mr. J. Grinan. The light, poor soil is irrigated by the Yallahs water and with the help of fertilisers a large crop of cane is obtained. Much of the land can not be ratooned. Here Mr. Grinan recently produced thirty-two tons of vacuum crystals from eight acres of D.95, that is four tons per acre as against a yield of two tons per acre from White Transparent. At this estate canes are bought from the peasants at 8s. to 12s. per ton according to quality and the owner informed me that he was offered more cane than he could deal with. Table XI gives analyses of the juice of D.95 as compared with the White Transparent from the last crop and from three very different soils. Albion is a light, loose soil under irrigation. Amity Hall is a sound loam under rather arid conditions. Holland a stiff clay, very difficult to drain. The general experience seems to be that D. 95 where it can be grown, is a very great improvement, as a source of sugar to the Transparent. Favourable conditions seem to be a light, well-drained soil and a fairly good rainfall or irrigation. On heavy, stiff soil the Transparent is the only cane, and this also holds with the arid districts already referred to.

TABLE XI.

Comparative Sugar-cane Analyses

Seedling D. 95, White Transparent, and Purple Streak.

Cane.	Estate.	Juice per cent. by mill.	Sucrose. Pounds per gallon.	Glucose. Pounds per gallon.	Quotient of purity.	Glucose ratio.
D. 95	Albion	59·1	1·82	·066	87·5	3·6
	Holland	54·5	2·43	·078	93·7	3·2
	Amity Hall	64·5	2·42	·083	92·4	3·4
White Transparent	Albion	58·8	1·64	·093	83·2	5·7
	Holland	55·0	2·28	·166	92·3	7·2
	Amity Hall	65·8	2·05	·173	86·1	·765
Purple Streak	Holland	57·8	2·24	·227	90·4	10·1

A great development of the sugar industry should arise if the owners of the splendid alluvial lands in the Plantain Garden district would abandon the fickle banana and decide to grow sugar-cane instead. Tables XII and XIII give the results of analyses of soils and subsoils recently made at the Government laboratory, which show what a splendid soil is here available for cane cultivation. With the liberal rainfall of the district and the D. 95 cane, I would predict three tons per acre of vacuum crystals as a normal output for this district.

TABLE XII.

ANALYSES OF SOILS FROM PLANTAIN GARDEN DISTRICT, ST. THOMAS, JAMAICA.

No.	Description.	Area in acres.	Nitrogen.	Humus soluble in ammonia.	Soluble in Hydrochloric Acid				Available	
					Potash.	Lime.	Phosphoric acid.	Chalk.	Potash.	Phosphoric acid.
1	Surface soil 9 inches ...	150	0·172	1·81	0·853	2·56	0·246	1·56	0·0128	0·0435
2	Surface soil 9 inches ...	50	0·143	2·02	0·352	3·96	0·168	2·91	0·0099	0·0247
3	Surface soil 9 inches ...	250	0·172	1·75	0·395	2·63	0·199	2·47	0·0047	0·0252
4	Surface soil 9 inches ...	150	0·196	1·67	0·783	2·80	0·201	0·29	0·0117	0·0228
5	Surface soil 9 inches ...	125	0·186	1·67	0·359	3·64	0·158	4·17	0·0081	0·0296
6	Surface soil 9 inches ...	125	0·170	1·86	0·458	2·95	0·204	1·83	0·0088	0·0287
7	Surface soil 9 inches ...	125	0·168	1·75	0·507	10·67	0·244	14·15	0·0042	0·0138
8	Surface soil 9 inches ...	125	0·152	1·36	0·240	2·67	0·139	1·99	0·0106	0·0148

TABLE XIII.

MECHANICAL ANALYSES OF SOILS FROM PLANTAIN GARDEN DISTRICT, ST. THOMAS, JAMAICA.

No.	Description.	Depth.	Stones.	Gravel.	Sand.	Fine Sand.	Silt.	Agricultl. clay.		Moisture.	Total.
								Fine Silt.	Clay.		
		in.									
1	Surface soil.	1-9	-	1·39	4·71	26·91	51·46	7·24	1·81	6·45	100·00
2	Surface soil.	9	-	2·92	7·94	29·16	45·00	6·15	1·55	7·28	100·00
3	Surface soil.	9	-	·69	3·81	29·33	45·83	10·29	1·30	8·75	100·00
4	Surface soil.	9		1·16	8·22	26·83	48·36	6·73	1·26	7·44	100·00
5	Surface soil.	9		·94	15·45	30·30	38·74	7·16	1·19	6·22	100·00
6	Surface soil.	9	-	3·40	5·52	30·68	47·35	5·13	0·51	7·41	100·00
7	Surface soil.	9		·67	13·31	25·38	45·44	7·35	1·37	6·48	100·00
8	Surface soil.	9		·17	1·99	39·67	46·38	6·02	traces	6·15	100·00
9	Subsoil	9-24		·40	9·06	30·41	42·57	9·75	2·85	4·96	100·00
10	Subsoil	25-36		·62	4·73	34·71	45·63	7·12	2·64	4·55	100·00
11	Subsoil	37-48	-	·20	2·49	41·11	44·71	6·23	0·92	4·31	100·00
12	Subsoil	9-24		·41	1·50	32·26	49·92	7·56	2·52	5·83	100·00
13	Subsoil	25-36		·32	2·12	35·43	48·74	6·19	1·86	5·34	100·00
14	Subsoil	37-48		·15	1·75	31·03	54·42	5·49	1·78	5·38	100·00

CONCLUSION.

Except for the arid districts where irrigation is not available, sugar has a bright future yet before it in Jamaica on modern lines. We can tell the world of capital that we can produce a ton of cane in Jamaica at a price that no other island of the West Indies can approach. Our agricultural position in the matter is unimpeachable. Faith, perseverance and work are alone needed to lift the sugar industry of Jamaica into the very foremost rank of the island's industries and sources of wealth.

RATOONING ESTATES AND CENTRAL FACTORIES IN JAMAICA.

BY JOSEPH SHORE.

Member of the Board of Agriculture, Jamaica.

It is proposed in this paper to deal with ratooning estates in Jamaica, giving a rough outline of the method of conducting them, of the cost of production of sugar and rum, and of their relation to Central factories in comparison with the present working. These ratooning estates are usually situated in the driest districts of the island, where the average annual rainfall rarely exceeds forty-two inches and is unequally distributed. The yield of canes is therefore less than in more favoured places, hence the figures here given afford a safe basis in considering the paying power of a central factory. So far these estates have nothing to turn to in the event of being compelled to shut up.

MANURING.

The same cane fields have been cultivated year after year for over a century, the soil being free, and the small rainfall not allowing of plants being put in regularly. A definite system is observed, whereby every cane-piece is manured every three years or so: one-tenth of the acreage being 'fly-penned.' and about one-fifth being manured with cattle-pen dung, every season. The 'fly-penning' is done by folding the cattle at nights on the freshly cut cane piece, an acre at a time, grass being spread over till the pen be covered when it is moved on to the next acre. This method affords a means of making the manure direct on the land and answers well in free soils. The cattle-pen dung is forked in around the roots just when the canes are beginning to joint, after the crop is over.

The vacant spots, that show up when the sprouts begin to grow after cutting, are 'supplied,' tops being planted with dung in these spaces (except in the penned land which does not require further manuring.) After the light May rains are over, any gaps left are 'stocked' during autumn rains by planting parts of the healthy stools in them, manure being applied both to the old stool and the plant. Some pieces are forked, in addition to those referred to, and a small amount of artificial fertilizer applied.

The cattle-pen dung is made in standing pens convenient to the works, where a lot of refuse megass etc. is collected: and in one or two spots near the cane-field, handy for the supplies. In these pens the stock are 'dressed' during the day, and folded at nights during the out-of-crop period. The usual allowance of working stock (cattle and mules) is rather under one head per acre, and a considerable amount of manure is made, sufficient for the upkeep of the estate, helped out perhaps with seaweed in the case of seaside properties. Of course each estate has a certain proportion of land in guinea-grass for supplying fodder to the pens and a good run of common pasture

for feeding the herd during the day. All this necessitates an expenditure for keeping up walls and fences, cleaning pastures, keeping up roads, and tending stock, in addition to the cultivation of the canefields. Plenty of wood for fuel is also a necessity, and this is got from the pasture land, where are generally pimento and logwood trees which help to bring in a little money to keep up the estate.

CULTIVATION.

The canes grown are what are known as 'white transparent,' 'striped transparent,' and 'black cane.' These seem to be the fittest for ratooning which have survived, all other kinds tried having failed in this respect. Many attempts have been made with new varieties which have done well on 'planting' estates—giving often fifty tons per acre but as yet not one has shown itself a good ratooner. Experiments are still being made in this direction, and it is hoped that good results may follow. The 'tops' for planting are carefully selected, only those that are stout and healthy, with no sign of borers, being used. There is very little evidence of the borer as a rule in the canes; though some estates are troubled with it. It has been found from careful observation that the planting of castor-oil plants in and about the fields has a marked effect in reducing the number of bored canes. This has also the effect of keeping away caterpillars from cassava and other cultivated plants, no doubt through the butterflies (swarms of which fly along at certain times) disliking the odour, and passing by.

Of late years planters in Jamaica have gone in more for draining, with good results, and the soil gets more turning up. Formerly manure was applied very heavily per acre, but now less is given with plenty of forking, and the applications are more frequent.

Much of the planter's time is taken up in preparing for and attending to the manufacture of produce: were the manufacture done in a factory more attention would be given to the field work and better results obtained.

MANUFACTURE.

Crop-time is usually from January to June or July, the weather being dry as a rule during that time except perhaps for a few showers in April and May. The process of manufacture is the ordinary muscovado, the cane-juice being boiled in an open battery with a Wetzell pan to finish up with, the sugar being centrifugalled and bagged. The cane mills are very ineffective, not extracting more than fifty-five per cent. There is a large quantity of molasses in the sugar which of course finds its way into the stillhouse and helps to make a large proportion of rum. Not more than fifty or fifty-five per cent. of the indicated sugar in the juice is recovered as sugar, the rum accounting for most of the balance: but there is a great waste in the crushing, fully fifteen per cent. of the weight of the cane being left in the megass in the form of juice, which would be a loss of twenty-seven per cent. on the crop at the lowest estimate.

The sugar polarizes 88 to 91, and the rum is what is known as 'good common' bringing, in the London market, slightly more than the quotation for 'common clean.'

COST OF PRODUCTION.

The cost of running a ratooning estate in not too favourable a situation is given as follows:—

	per acre.			per ton cane.	
	£	s	d	s	d
Labourers' wages, including cultivation of cane-fields, manuring, cleaning pastures, walls and fences, attending stock, headmen and watchmen, tradesmen, carrying produce to wharf, etc., burning lime, repairing estates' roads, and manufacturing produce	7	0	0	7	9
Purchase of stock		18	0	1	0
Lumber and supplies, bags and shooks	1	5	6	1	5
Taxes and rates		4	0		$2\frac{3}{4}$
Wharfage		3	0		2
Salaries including engineer ...	1	13	0	1	10
Sundries, including drogherage, etc.		6	6		$4\frac{1}{4}$
Total cost ...	£11.	10.	0	12.	9

These figures are based upon the average of five estates on the north side, containing in all 900 acres of canes. The yearly average return is eighteen tons canes per acre, and the average crop is 660 tons sugar and 530 puncheons (each 120 gallons) of rum—a total of 1,190 casks from 900 acres. As rum is of as much consideration as sugar (often of more), planters generally count the number of casks (sugar and rum together) in figuring the crops and expenses.

This return shows sugar as ·74 ton per acre, and rum as ·59 puncheon—a total of 1·33 per acre: the proportion of rum being nearly 100 gallons per ton of sugar. At this rate the cost per cask is £8. 12. 6. placed in shipping port.

At present low prices the receipts per acre are:—

	£	s	d
·74 ton sugar at £7 net	5	3	7
·59 puncheon rum at £8 net	4	14	5
	£9.	18.	0

or a loss of £1. 12 per acre of canes

If these estates grew canes and supplied them to a factory the cost would be much reduced by reason of there being no need to keep the tradesmen, and no need of such expensive management where no manufacturing would be done.

The cost in such case would be :—

	per acre.			per ton cane.	
	£	s	d	s	d
Labourers' wages	4	0	0	4	5½
Purchase of stock		16	0		10½
Lumber and supplies ...		4	0		2¾
Taxes and rates		4	0		2¾
Salaries	1	0	0	1	1½
Sundries, including extra manure		6	0		4
	£6.	10.	0	7.	3

This works out at 7*s.* 3*d.* per ton of canes delivered, but does not include rent of estate, which will be about 24*s.* per acre of canes, making the cost 8*s.* 6*d.* per ton, or a profit at 10*s.* per ton, of 27*s.* per acre.

On many planting estates in good districts, where the return per acre reaches an average of twenty-five tons and over, canes can be raised at a cost of 6*s.* per ton: but this can only be done where the acreage is large and the land level. On these estates sugar can still be produced at a profit under the old system, the large acreage advantageously placed as regards both situation and rainfall, turning out big crops for very little extra expense in management and manure.

Were a factory to be started in the district referred to, the same acreage of canes, 900, would with the latest improved appliances and double crushing turn out at least 1,250 tons sugar and 300 puncheons rum - a total of 1,550 casks against 1,190 at present: an increase of thirty per cent. The sugar would be of the best quality fit for home consumption and for grocery purposes in the United Kingdom thus rendering the industry independent of the American market. The cost of production of sugar in the factory would be as follows, allowing for a standard of 9 Baumé for cane juice, and an extraction of at least seventy per cent. from mills, with a recovery of eighty per cent. of sugar:

	£	s	d
Canes, say 13 tons at 10*s.*	6	10	0
Hands in works		8	0
Bags, oil and stores		8	0
Fuel		4	0
Rent, taxes, insurance, etc.		6	0
Wharf hands, drogherage, etc.		4	0
Salaries		10	0
Total cost per ton, free on board	£8.	10.	0

A factory to work up the above quantity would cost not more than £12,000 erected, and the profit on the sugar (taking the present market price in London 15*s.* 9*d.* less 5*s.* 9*d.* duty and expenses) would be 30*s.* per ton. The rum would net

(deducting cost of manufacture and cask) at least £6 per puncheon ; so that the profits would be :—

1,250 tons sugar at 30s.	..	...	£1,875
300 puncheons rum at £6...	...	...	1,800
			£3,675

or a return of fully 30 per cent. on capital laid out.

This estimate is based on the understanding that the works of one of the estates be utilized, necessary alterations being made : and also that a wharf be leased where the produce can be droghered coast-wise to the vessels that export it.

Thus far these figures only take into account the present acreage, but in all districts there are a number of settlers and small land-owners who would be glad to grow canes and sell them to the factory, thus increasing the output of sugar. From these settlers there may reasonably be expected an additional fifteen or twenty per cent. of canes, and the factory would do the most good in their case as they would have a steady market for a product they like to cultivate better than any other—a product which is the only one to be depended on in these dry districts where fruit does not do well.

SUBSIDIARY INDUSTRIES.

The sugar question is not the only one, however, that a factory can take up. The machinery for sugar alone would only be at work for three or four months at most, lying idle for the remainder of the year. To be of more benefit to the community at large, the factory might have in addition to the appliances for sugar-making, apparatus for pulping and curing coffee : for making starch from cassava (which is a very common article of cultivation) ; for pressing oil from the seeds etc. of the numerous oil-producing plants ; for extracting fibre from cocoa-nut husks and the many fibre plants that grow in these districts ; and for sawing veneers from the valuable mahogany and other hard-woods so common there also.

A fair proportion of sugar made would be refined during the process of manufacture, thus supplying white sugar suitable for preserving and canning. It seems strange that in a country where sugar is made and where oranges grow wild no marmalade is made for export, but a large quantity is imported. The same remark holds good in regard to other fruits such as guavas, mangos, etc. which could be canned and exported largely.

GOVERNMENT ASSISTANCE

It must be understood that the land is very undulating, rising from sea-level up to an elevation of over 1000 feet. The canefields are in the hollows and on the gentle slopes ; the higher land and the rocky hills being pasture or woodland. The settlers are generally higher up than the estates, and grow cocoa-nuts, cassava, coffee, and perhaps a little cacao in the

sheltered glades. The factory might then be the centre for purchasing and properly preparing for market all the products that grow in the neighbourhood, and this can easily be done outside of the sugar season at a very small cost for preparation, the motive power for the appliances being already established.

It is but right that the Government should give financial assistance (not subsidies) in starting factories of the kind proposed here: especially in districts where at present fruit can hardly be grown, but where there are other products—which can only be properly handled on a large scale—undeveloped.

A loan for this purpose would be the best investment the Government has yet tried, and would, besides returning all the capital with interest, result in rendering the country prosperous, and yielding much larger revenue, collected from a people able and willing to pay. There is no need that the matter be gone into blindly, but that proper estimates be obtained beforehand as to the paying power of the factories in the different districts, and due security taken. By making the factories co-operative the risk would be taken by all concerned and the profits divided among them in proportion to supply.

At these institutions agricultural training could also be given to the people in a practical way, experiments being conducted by skilled men, in view of all that care to interest themselves. In fact the factory should be not only a centre for the purchase of products in the raw state, but also a centre of instruction in agriculture whereby these products may be increased.

DISCUSSION.

The Hon'ble F. WATTS (Leeward Islands): In 1890, when I left Jamaica, there was a general tendency to abandon sugar for banana cultivation and I placed before the Governor, in a semi-official manner, my ideas of the possibilities of the sugar industry and pointed out the desirability of devoting more attention to it. I am glad to notice from the papers read, that there is now a tendency to inquire into the possibility of increasing the production of sugar and introducing Central factories. I am of opinion that the development of the sugar industry, on Central factory lines, in the deep-soil districts of Jamaica, would be a safe and sure undertaking, more so than in some of the smaller islands. This opinion is supported by the figures put before us as to the cost of sugar production in those districts, showing it to be possible to produce canes at something like 6*s*. per ton. That seems, however, a rather low estimate; but I adhere to the opinion that a system of Central factories in the plains of Vere assisted by a scheme of irrigation, would be a good thing for Jamaica, and I hope that in a short time, with the agitation that there is in the West Indies for Central factories, the Jamaica scheme will come to fruition. Certain estates were spoken of as 'ratooning continuously.' That, I take it, means that there is no replanting

of canes, little cultivation, and that the planter is content, year after year, with such crops as nature gives. That certainly points to the fact that in these localities there must be a wonderful depth of soil and marvellous fertility. If the Jamaica planter fully utilises this great fertility by cultivation, the sugar industry of the island, even with the very low prices obtaining, need not be neglected.

One is almost horrified to hear Mr. Shore say that the amount of sugar extracted from the juice of the cane is from 50 to 55 per cent. It was however qualified by the statement that a great deal of this apparent loss was regained in rum. The Jamaica planters should remember that they are making German rum which is used to undersell Jamaica rum. Whether this is a wise thing to do is a matter for them to consider.

The Hon'ble S. OLIVIER (Jamaica): I am only an amateur of sugar cultivation and manufacture, but I have taken great interest in those industries and have had good opportunities of observing them in all the West Indian Colonies. I must say that when I first visited sugar estates in Jamaica, and especially those ratooning estates of which Mr. Shore has spoken. I was a good deal shocked both at the methods of manufacture and the aspect of the crop. The crop on these ratooning estates in Trelawny and St. James is a dense growth of short slender cane with a surprising number of rings, and it was a mystery to me how any profit could be made out of such cultivation. The explanation in regard to these estates lies in the special value of their rum. The survival of the sugar industry in other parts of Jamaica is due to the extraordinary character of the soil in certain favoured districts. The plains of Vere and St. Thomas-in-the-East are deep deposits of alluvial mud washed down from hills of old volcanic detritus. The Westmoreland sugar estates lie in a well watered alluvial plain of partly similar origin. We have held our own in Jamaica more by good fortune in such soils than by our own deservings, whilst planters in other islands who deserved more of the industry, both in regard to their cultivation and to their manufacture, have gone under. But having survived and having learnt from the example of Colonel Ward, Mr. Grinan, and other enterprising planters what our soils can do for us with even moderate improvement in machinery, I think we have come to the conclusion that we can prove that Central factories have a better chance of success in some parts of Jamaica than almost anywhere else. We owe much to Mr. Francis Watts for encouraging us to open this line in Jamaica: we have been following it up: we have been waiting patiently to hear what was to be done in Barbados and Antigua, but having got rather tired of waiting we have now formulated schemes for certain factories on our own account, which we hope we may, before long, be able to bring into being.

The PRESIDENT: We have had a singularly interesting account of the sugar industry in Jamaica. There are no doubt many present who would be glad to learn how it is possible, in any part of Jamaica, to produce canes at a profit at six shillings per ton. In Barbados it is said to cost on an average about

twelve shillings and at Antigua about ten shillings to produce a ton of canes. The success of Central factories depends almost entirely on the cost of canes. The information placed before us to-day shows that in some districts of Jamaica, Central factories should have good prospects of success. I believe that all Central factories in the West Indies should be worked on co-operative principles. The planter who takes the greater part of the risk should receive, in addition to an agreed price for his canes, a fair share of the profits of the factory in order to meet losses to which his crops are exposed by insect and fungus pests, hurricanes, etc. It was hoped that Central factories would have been already established at Barbados and Antigua. Even if bounties were abolished to-morrow, Central factories would still be necessary, for the smaller West Indian Colonies could not hope to compete on equal terms with countries where the highest skill and the best machinery are already enlisted in the industry.

THE FIELD TREATMENT OF CANE CUTTINGS IN REFERENCE TO FUNGOID DISEASES.

BY ALBERT HOWARD, B.A., A.R.C.S., F.L.S., F.C.S.

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During the planting season of 1900-1 in Barbados my attention was arrested by the large number of cane cuttings* which either did not grow at all, or the young shoots died shortly after they appeared above ground. On some of the estates the amount of 'supplying' which had to be done was large and above 30 per cent., which a good many planters say is the average as a general rule. On examining a very large number of these dead cuttings, it was found that they were filled with fungus mycelium and spores which were identical in the majority of cases, and were found to belong to the same fungus. It appeared probable therefore that this fungus might have something to do with the non-germination of the cuttings in which it occurred and that, in general, the failure of cuttings to grow might be due to the attacks of fungi and especially of this particular fungus. The economic importance of the subject appeared to justify an inquiry into the whole question.

The general impression among practical men as to the death of the cuttings was that it was due to drought, and it

* In this paper 'cuttings' refer to pieces of the stem of the cane which do not include the main growing point. Those portions which include the main growing point are referred to as 'tops.'

must be admitted that this view has been found to be partly correct, but the part played in the question by another factor —fungi—was not realised. Indeed, the existence of a definite fungoid disease of cane cuttings in the West Indies does not seem to have been noted before. At any rate I can find no reference to it in the literature of the subject.

CAUSE OF DISEASE.

The particular fungus referred to above was found to be identical with *Thielaviopsis ethaceticus*, which causes a disease of cane-cuttings in Java known as the pine-apple disease, first investigated by Professor Went (2) at the West Java Experiment station in 1893 and afterwards by Dr. Wakker (3) at the East Java station. It is proposed to give the name of the pine-apple disease to this disease of cane-cuttings in the West Indies, both on account of the fact that it was originally so described by Prof. Went and also on account of the characteristic odour of pine-apples which can be detected on splitting open canes or cuttings attacked by the disease. The fungus has been noted in Barbados, Trinidad, Grenada, St. Lucia, St. Vincent, and Dominica and on specimens from Surinam, British Guiana, and Antigua, so that it is probable that it occurs in all the West Indian Colonies where the sugar-cane is cultivated. It is quite common on 'rotten' canes, on heaps of discarded cuttings and the waste cane left in estate yards at planting time. Hence all 'rotten' canes should be destroyed and the heaps of cane left over at planting time got rid of daily. The fungus occurs also in Antigua pine-apples gaining access at bruised surfaces, and is one of the causes of the decay of these fruits during transit.

The life-history of the fungus has been worked out in the laboratory of the Department of Agriculture and Prof. Went's (2, 6, 7) results have been confirmed and some additional facts established. The fungus forms brown spores (*conidia*) in large numbers and with great rapidity; they are easily distributed and can be seen with the naked eye on affected cuttings as a black mould. The life-history of this fungus is described and figured in No. vii of the *Lectures to Planters* delivered in Barbados in 1901, to be published in book form. It has been proved to be identical with the macro-and micro-conidial stages of Mr. G. Massee's *Trichosphaeria Sacchari* and is described by Mr. Massee (1) and the writer (9) in the *Annals of Botany*. The life-history is simple. On the exhaustion of the material on which the fungus is living two kinds of spores (macro and micro-conidia) are produced in a similar way from certain portions of the fungus. The larger spores (macro-conidia) are formed in the interior of the cutting while the smaller ones (micro-conidia) are formed at the cut ends as a rule. Both forms of spore are produced by the contents of certain parts of the mycelium of the fungus collecting into blocks, and these portions look like tubes filled with a row of beads. After a short time the ends of these parts of the mycelium break down and the blocks are forced out as a chain of spores. These are colourless at first but soon become dark-brown, and being

produced in great numbers give a black mouldy appearance to the cuttings in which they are formed. These spores germinate very quickly, in an hour or so, and to this is due the rapidity with which the fungus is able to destroy heaps of cuttings.

It was found that when sound cuttings are dipped in water containing the spores of *Thielaviopsis* that infection takes place at the cut ends, and that when these are coated with paraffin wax that infection takes place at a bruise or at cracks in the rind. Infection also takes place when sound and diseased cuttings are mixed together and it was found that the spores are the means by which this is brought about. Fifty of such infected cuttings on being planted died, and were found on examination to be penetrated by the fungus in all directions. Fifty similar but uninfected cuttings planted at the same time germinated normally and gave rise to young canes in the usual way.

Having in this way proved that this fungus is the cause of death of many cuttings, and that infection takes place by spores at the cut ends or at bruises or cracks, it was possible to study intelligently the question of protecting cane cuttings against this disease.

REMEDIES.

The method originally adopted by Professor Went (2) in Java in 1893 was to coat the cut ends of the cuttings with tar mixed with a little arrack. Referring to this method in 1896 Professor Went (6) writes:-

'The means of preventing the disease are very simple. They consist in protecting from the air the cut surfaces of the cuttings. This is done by means of tar, previously rendered more liquid by the addition of a little arrack. On estates where this method is employed the disease has ceased to show itself.'

Later the subject was investigated by Dr. Kamerling (8) at the West Java station in 1900, who compared the germinating power of two-eyed cuttings (that is, cuttings bearing two lateral buds or eyes) when treated with tar and Bordeaux mixture respectively. He found that a larger number of buds germinated in the latter case than when tar was used. His experiments however are open to objection, and I have been unable to confirm his results.

These Java methods of treating cane cuttings are apparently new to the West Indies, and it occurred to the writer that in all probability dipping the cuttings first in Bordeaux mixture and then tarring the ends would be likely to give the best results since in this way the cut ends, the weakest places in the defensive armour of the cuttings, are doubly protected, and further any cracks or bruises are rendered fungus-proof by the Bordeaux mixture, and at the same time fungi round the node are either destroyed or their development prevented. It appeared desirable therefore to test the value of tar, Bordeaux mixture and the combined treatment in protecting cuttings from fungoid attack. At the same time the methods in use in

Barbados—namely soaking the cuttings in water alone, lime wash and Queensland solution*—could be examined.

The first thing to do obviously was to find out whether Bordeaux mixture and tar harm the cuttings in any way, and accordingly the germinating power of similar cuttings, some untreated and the others dipped in Bordeaux mixture and then tarred, was compared. In the first experiment two sets of twenty-five three-eyed cuttings were used and planted flat. Twenty-one days afterwards it was found that all the cuttings had grown but that only thirty out of seventy-five eyes had developed in the untreated cuttings, while seventy-three out of seventy-five had developed in those treated with Bordeaux mixture and tar. The weather however was extremely wet during this experiment and the cuttings were under water for some time. The experiment was then repeated and two sets of one hundred three-eyed cuttings were used.

Twenty-one days afterwards the results were found to be:—

TABLE I.

	No. of cuttings developed.	No. of eyes developed.	Percentage of eyes developed
Treated with Bordeaux mixture and tar	100	267	89
Untreated	100	250	83

The results of these experiments show that the double treatment certainly has no injurious effect of the germinating power of the cuttings.

It now became necessary to test the value of Bordeaux mixture and tar when used alone and combined in protecting the cuttings from infection. Accordingly 400 three-eyed cuttings and 100 tops were treated as follows:—

TABLE II.

A.	100 tops	Untreated and infected with spores of *Thielariopsis ethaceticus.*	
B.	100 cuttings	,,	,,
C.	100 ,,	Tarred	,,
D.	100 ,,	Bordeaux mixture	,,
E.	100 ,,	Bordeaux mixture and tar	,,

* Queensland solution is prepared by mixing one pint of crude carbolic acid with 100 gallons of water.

Twenty-eight days afterwards the cuttings were examined with the following results:—

TABLE III.

		Total no. of eyes developed.	Percentage of eyes developed.	Percentage of cuttings which grew.
Tops.	A.	71	24	44
Cuttings	B.	11	3	9
„	C.	153	51	85
„	D.	224	75	98
„	E.	232	77	100

These results show that Bordeaux mixture alone or combined with tar is very effective in preventing infection and better than tar. They also show that 'tops' are not so easily destroyed by the fungus as 'cuttings.' This latter result was again obtained on repeating the experiment with 100 untreated and infected tops when forty per cent. were found to grow while sixty per cent. were destroyed. On repeating this experiment a third time, during which the weather was much drier, only twenty-six per cent. of the infected tops developed. The reasons why these results were obtained are given later when discussing the general bearing of the experiments.

Next it was desirable to test the value of the methods now in vogue in Barbados for the treatment of cuttings, namely, soaking in water, in lime wash, and in Queensland solution

Accordingly 500 three-eyed cuttings were treated as follows:-

TABLE IV.

A.	100 cuttings		Bordeaux and tar	Infected with spores.
B.	100	„	Water for 12 hours	„
C.	100	„	Lime wash for 12 hours	„
D.	100	„	Queensland solution for 12 hours	„
E.	100	„	Untreated	„

Twenty-eight days afterwards the cuttings were examined with the following results:—

TABLE V.

	No. of eyes developed.	Percentage of eyes developed.	Percentage of cuttings developed.
A.	247	82	97
B.	32	11	15
C.	48	16	20
D.	25	8	18
E.	10	3	5

These results show that none of the present methods are to be compared in efficiency with Bordeaux mixture and tar. They have no doubt been of some use, as cuttings immersed in water, lime wash or Queensland solution are not so likely to

become infected when submerged as when allowed to remain in the open in the estate yard. Again soaking with water no doubt removes some of the sugar from the cells of the cuttings near the ends and thus renders it a little more difficult for the fungus to gain entry.

It is evident that the treatment with Bordeaux mixture and tar and with Bordeaux mixture alone are by far the best of those tested up to the present and are practically perfect. Which of these two will ultimately be found to give the better results can only be determined by experiment on a large scale on the estates themselves. In the tests described above only one hundred cuttings (sufficient for one-twelfth of an acre) were used and the results cannot be expressed in terms of an acre since any error would be multiplied twelve times in the final result. The results obtained however serve to establish a case for experiments on a large scale which it is hoped the planters will make for themselves. All that is necessary is to take a four acre field and treat the cuttings on each acre as follows:—

TABLE VI.

Untreated.	Soaked in water, lime wash, or Queensland solution according to the regular estate practice.	Twelve hours in Bordeaux mixture.	Twelve hours in Bordeaux mixture and then tarred.

The number of 'supplies' in each plot should be recorded and the general character of the 'spring' noted. If in addition the canes are weighed at crop time the advantage of establishing a uniform spring at the first planting will be determined. It is reasonable to suppose that the plots which grow uniformly from the beginning will give a higher tonnage of canes, or at any rate more sugar than those where a considerable amount of supplying has to be done. Again, if the canes grow after the first planting they will, in Barbados, be established before the dry season sets in. In all the experiments described above the climatic conditions were exceptionally favourable to the cuttings. Rain fell in abundance and therefore a good 'spring' resulted. As however such favourable conditions are by no means the rule but drought is often experienced at planting time, it appeared desirable to conduct further experiments during a period of comparative drought. Such unfavourable conditions might be expected to throw light on the comparative value of treating cuttings with Bordeaux mixture and tar or with Bordeaux mixture alone. The double treatment ought to give the better result. Further it appeared desirable to compare the

effect of dipping cuttings in Bordeaux mixture with that obtained by dipping them first in a solution of copper sulphate and then in lime wash. In this latter case Bordeaux mixture would be formed *on* the cutting and might be more efficacious than when cuttings are dipped in previously prepared Bordeaux mixture. Accordingly an experiment was started on December 18th, that is, after the usual planting time in Barbados, with 600 three-eyed cuttings and 300 tops which were treated as follows:—

TABLE VII.

A. 100 cuttings ...	untreated and uninfected.
B. 100 cuttings ...	untreated and infected with spores of *Thielaviopsis*.
C. 100 tops ...	untreated and similarly infected.
D. 100 cuttings ...	dipped for one minute in 2½ per cent. solution* of copper sulphate and then in lime wash. The cut ends were then tarred and the cuttings infected with spores of *Thielaviopsis*.
E. 100 cuttings ..	dipped in copper sulphate solution and then in lime as in D, and afterwards infected with spores.
F. 100 tops	treated similarly to E.
G. 100 cuttings	treated with Bordeaux mixture and tar and then infected.
H. 100 cuttings	treated with Bordeaux mixture alone and then infected.
I. 100 tops	treated similarly to H.

The cuttings were examined on February 19th, two months after planting. During this period the rainfall amounted to 2·03 inches only. Sixty-four parts (·64 inches) fell from December 18—31 inclusive. ·93 inches during January, and ·46 inches from February 1 – 19. During the period October 18 to December 18 during which the majority of the above experiments were conducted, the rainfall on the same field was 13·5 inches.

*A 2½ per cent. solution of copper sulphate means one which is made by dissolving 2½ pounds of the sulphate in 100 pounds of water. Since one gallon of water weighs 10 pounds, a 2½ per cent. solution is made by dissolving 2½ pounds of copper sulphate in 10 gallons of water.

The result of the above experiment was as follows :-

TABLE VIII.

	Total buds germinated.	Percentage buds germinated.	Percentage cuttings germinated.
A.	22	7	22
B.	2	1	2
C.	16	5	16
D.	84	28	72
E.	16	5	16
F.	64	21	56
G.	128	43	96
H.	52	17	44
I.	64	21	48

The result shows the high mortality among unprotected cuttings when planted in the ordinary way during unfavourable climatic conditions. In this case 78 per cent. of the cuttings died. The result of B and C shows a difference in favour of infected tops over infected cuttings of fourteen per cent. This result corresponds, in a general way, with that given in Table III above, but in this latter case the numbers are 16 and 2, while in the former they are 44 and 0. The difference is on doubt due to the conditions of germination being more favourable during the experiment quoted in Table III.

The germination of D and E shows the double treatment is far better than that with copper sulphate and lime wash alone, the difference in favour of the former being 56 per cent. Further, the tops in F showed an increase of 40 per cent. over the cuttings in E.

The result of G and H show a difference of 52 per cent. in favour of Bordeaux mixture and tar over Bordeaux mixture alone, while the difference of 24 per cent. between G and D indicates the advantage of dipping in Bordeaux mixture over that of immersing them for a minute in 2½ per cent. copper sulphate solution and then passing them through lime wash. This result is also borne out by comparing H and E, when the difference in favour of Bordeaux mixture over copper sulphate and lime separately is twenty-eight per cent.

The result of this experiment therefore indicates that the treatment of cane cuttings with Bordeaux mixture and tar is practically perfect, and can be relied on during periods of

comparative drought. It is only under such adverse conditions that the superiority of the double treatment over Bordeaux mixture alone is apparent. Since the weather conditions cannot be anticipated, it is clear that the double treatment is the more reliable.

Another advantage of tar in addition to Bordeaux mixture was strikingly brought out during the experiment started on December 18. It was found, on examining the cuttings on February 19, that in all the series except D and G when tar was used, the larvae of the weevil borer (*Sphenophorus sericeus*) had invaded the cuttings to a very great extent. None were noted however in D and G where the cut ends of the cuttings were tarred. Hence since cuttings treated with Bordeaux mixture alone are liable to be attacked by borers in the ground and therefore rendered an easy prey to fungi, and since Bordeaux mixture and tar keeps out this borer, we have another argument in favour of the double treatment.*

BORDEAUX MIXTURE.

Probably the best method of preparing Bordeaux mixture for cane cuttings is that based on Dr. W. T. Swingle's (4) researches, which is quoted in the *West Indian Bulletin* Vol. II, p. 210. Prepared in this way the fungicide adheres firmly to the cut ends and also covers up any bruised surfaces of the cutting. After immersion for six to twelve hours or even less the cuttings can be allowed to dry and then tarred on the ends. The tar should be rendered more liquid by the addition of half a pint of methylated spirit or kerosene oil to each gallon of tar. In this way its adhesive power is considerably increased. It is advisable to place the cuttings in Bordeaux mixture immediately they are prepared, and not to leave them in heaps for any length of time before treatment.

COST OF TREATMENT.

The cost of the treatment is very small, and works out as follows:-

Fifty gallons of Bordeaux mixture will treat 25,000 cuttings sufficient for 20 acres and cost 72 cents:

	Dollars.
6 lb. of copper sulphate at 10 cents per lb. ...	·60
4 lb. of lime (unslacked) . . .	·04
Labour	·08
	$ 0·72

One gallon of tar at 10 cents will coat the ends of 6,000 cuttings (sufficient for five acres). The cost of the tar per acre is therefore two cents.

Four boys, at eight cents, will treat 6,000 cuttings in a day with Bordeaux mixture and tar. The cost of labour per acre is therefore 6 cents.

* This experiment (Dec. 18 to February 19) was completed, and the account has been written, since the Conference.

The cost of treatment per acre with Bordeaux mixture and tar is therefore:—

	Dollars.
Bordeaux mixture	·04
Tar	·02
Labour	·06
	·12

For Bordeaux mixture alone the cost is:—

Bordeaux mixture	·04
Labour	·02
	·06

Thus the cost works out at twelve dollars per 100 acres for the double treatment, and six dollars per 100 acres for Bordeaux mixture alone, where 1,200 cuttings to the acre are planted.

PROTECTION OF CUTTINGS IN TRANSPORT.

Since a considerable amount of exchange of cuttings goes on in the various Colonies themselves, and also between Colonies, and since many of the cuttings are frequently destroyed in transit by fungi, it appeared desirable to compare the germinating power of treated and untreated cuttings after being kept in a well ventilated barrel for fifteen days, which would represent the maximum time taken in transport between the various West Indian sugar Colonies. Accordingly an experiment was made with two sets of one hundred three-eyed cuttings, one set being treated with Bordeaux mixture and tar and the other left untreated. Twenty-eight days after planting the results were:—

TABLE IX.

	Total eyes germinated.	Percentage of eyes germinated.	Percentage of cuttings established.
Treated	200	66	91
Untreated	77	25	50

Evidently therefore, all cuttings which are sent to other Colonies, or to different parts of the same Colony, should be treated in the manner indicated.

GENERAL CONSIDERATIONS.

It now remains to deal with the experiments as a whole, to emphasise the conclusions based on them, and further to indicate the manner in which they throw light on some points of local agricultural practice.

In the preparation of the cuttings used in these experiments a considerable number were discarded on account of the presence in them of borer tunnels. Some of these were treated

with Bordeaux mixture and planted separately, and were examined a month later. Frequently these cuttings either did not germinate at all, or if they did, the shoots died off shortly after they appeared above ground. It was found that this was caused by the inroads of fungi which had established themselves in the cuttings at these weak points, probably before the treatment with Bordeaux mixture. Cuttings attacked by borers should therefore be rigidly excluded although they may appear sound from outward appearances. The losses suffered by their use must be out of all proportion to the small additional cost of really sound cuttings.

The above experiments explain why some methods in use in Barbados have been adopted and for which the planters have often been blamed. It is a matter of common knowledge that planters prefer to use tops rather than cuttings, and, further, ratoons than first crop canes to establish a new stand, since they know by experience that such material grows best. The above experiments throw a flood of light on this practice. The planter has either found out by experience or the information has been handed down from past generations as a tradition, that cuttings and tops from poor looking ratoons germinate better than those from the best canes, and further that a top can be relied upon far more than the finest looking cutting. The explanation of this practice seems to be as follows. Professor Went (5) has shown that the sucrose content of a cane, starting from the lowest joint and passing upwards, rapidly reaches a maximum and then slowly falls off till near the top where a big drop is experienced and in the top itself practically becomes nil. Hence cuttings are comparatively rich in sugar while tops are very poor in this substance. I have found that the pine-apple fungus develops much more rapidly and luxuriantly in the juice from the centre of a cane than in that from tops, and further that cuttings are much more rapidly destroyed by the fungus than tops. Since the death of cuttings in the ground is really due to fungoid attack and principally to that of *Thielariopsis*, we reach the conclusion that this fungus has driven the planter to his present system of selecting planting material. Further, the principal obstacles to the passage of the fungus through a cutting are the nodes where the fibres are massed together and form barriers. Hence cuttings from poor ratoons with short internodes and numerous nodes are better adapted to check the fungus than finer cuttings, since they possess more of these barriers per linear foot and also are poorer in sugar. Further, the smaller ratoon cuttings have more eyes (buds) per linear foot than those of first crop canes, and therefore have more chances to germinate. Tops are better able to withstand the fungus than cuttings as they are poorer in sugar, possess more nodes per unit of length, and also contain more active cells whose protoplasm can resist the onward march of the fungus. Hence we see that the system of the past in selecting planting material was the only one possible. Now, however, when an efficient system of protecting cuttings is available and when practically every one can be relied upon to grow, the whole question wears a new aspect.

It would appear that the present system of planting is calculated to produce degeneration of the particular varieties employed. Since the vegetative vigour of any stand of canes is greatest in the first crop and falls off in succeeding crops and since in vegetative reproduction from cuttings, like tends to beget like, it is reasonable to suppose that the potentialities of the buds of the cuttings from any stand are greatest in the first crop and fall off in succeeding crops. Hence to conserve the desirable characters of a variety we should plant from the best canes and use cuttings rather than tops. In the past this was not possible on account of the destruction by fungi of unprotected cuttings rich in sugar, but it is possible in the future. To test this view it would be necessary to plant fields one half with the best first crop cuttings and the other half with poor second or third crop cuttings of the same variety the cuttings being protected in each case -and compare the results for a number of years. The results of such experiments would be of the very greatest interest and importance.

It will be seen further that in the germination of cane cuttings in the ground there is often a struggle between the cutting in its efforts to establish itself and between the fungi which try to destroy it. Obviously therefore in good years when the rains fall seasonably the cuttings are favoured in the struggle and a large number succeed. In dry times the conditions do not favour the germination of the cutting and at the same time do not check the fungi which attack them, so that in this case the fungi often win and many cuttings perish. This is well seen in the germination of infected tops in the experiments referred to in this paper. Hence when the planter says drought kills the cuttings he is partly correct. To be more correct he should say that drought handicaps the cuttings in their struggle with their fungoid enemies to such an extent that many of the cuttings are killed. In protecting cuttings with Bordeaux mixture and tar, or with Bordeaux mixture alone, an unexpected factor man himself interferes in the contest between the cuttings and their foes, and turns the struggle in favour of the cutting, that is to say, in favour of himself. It is a good example of the service that can be rendered to agriculture by the plant pathologist and of the economic value of the study of plant diseases.

SUMMARY.

The conclusions arrived at in this paper may be summed up as follows:—

1. The non-germination of cane cuttings is caused principally by the fungus *Thielaviopsis ethaceticus* which is spread by spores and which infects the cuttings principally at their cut ends. Cuttings are often destroyed in transit by this fungus.

2. The fungus occurs on rotten canes, on discarded cuttings and on the heaps of waste cane left about at planting time, Hence rotten canes should be destroyed by burning and all waste cane at planting time disposed of daily.

3. The fungus probably occurs in all the West Indian islands where the sugar-cane is cultivated.

4. The most effective way of preventing the inroads of the fungus is the treatment of cuttings with Bordeaux mixture and tar. Cuttings should also be so treated before they are sent to other parts of a Colony or to other Colonies.

5. Cuttings on account of their greater sugar content, fewer nodes and less resistant power, are destroyed more quickly than tops.

6. Cuttings with borer holes should not be used in planting.

7. The inroads of fungi have probably brought about the present selection of planting material which very likely tends to the degeneration of cane varieties.

8. It is suggested that a new stand should be established from the best canes since, in vegetative reproduction from cuttings, like tends to beget like. Such cuttings should be protected in the way indicated.

9. When cuttings germinate there is often a struggle between the cutting and its fungoid pests. Favourable weather favours the cutting and drought favours the fungus in the struggle. Hence man should turn the battle in favour of the cutting by efficiently protecting it.

Before concluding this paper I wish, at the request of the President, to supplement the statement I made at the last Conference concerning cane trash, namely, that 'so far as my experiments have gone I have very rarely found these spores [of the rind fungus] on cane trash, so that until it has been definitely proved that trash is a dangerous article there is no reason why any change in the present useful practice of mulching young canes with this substance should be made' (*West Indian Bulletin*, Vol II. p. 50.) Since that time I have examined many thousands of cane leaves and as far as the fungus referred to above is concerned, have no reason to alter the opinion I expressed last year. It has been found however that another fungus, namely *Colletotrichum falcatum*, Went, which has been shown to be a very dangerous sugar-cane parasite, occurs on the trash from canes attacked by rind disease to a sufficient extent to render such trash a dangerous material for mulching young canes. Before, however, planters can be advised to burn their trash generally, as seems to be done in Java, it will be necessary to prove that the harm done by the parasites on cane trash is greater than the benefits resulting from its use.

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DISCUSSION.

The Hon'ble C. A. Shand (Antigua) : The very interesting paper just read illustrates the greater vitality of the plant cut from the top as compared with that cut from the cane itself which Mr. Howard designates as 'cuttings.' This has long been apparent to me from a series of experiments I made which indicated a difference of about 50 per cent. in favour of the cane-top plant. I did not understand before the reason for the extraordinary difference. The aim of the planter should be to establish his cane field *ab initio* and thus avoid the cost of supplying and loss from the cane being of different ages. I would suggest to the President the advisability of making experiments to determine the best planting season, as it does not follow that the time which suited the Bourbon is the most favourable for the new varieties.

The President : Did you treat the cuttings in any way before they were planted.

Mr. Shand : I soaked them in a solution of one gallon of Jeyes' fluid to 100 gallons of water.

The President : Have you tried an experiment to compare the results with treated and untreated cuttings.

Mr. Shand : I have not.

Dr. H. A. A. Nicholls (Dominica): Some of our French neighbours have, by experiment, determined the value of tar

as a remedy for fungoid diseases of the cane. Sometime ago a gentleman residing in Guadeloupe communicated an account of these experiments to the Dominica Agricultural Society. I have not sufficient recollection of the details of the methods employed to be able to lay them before the Conference.*

The PRESIDENT : In Java the method of treatment is very simple. A number of plants are set on end, bound together and then dipped upright into a shallow vessel containing liquid tar. They are then taken out and laid aside to allow the tar to harden. I understand from Professor Went that the result is very satisfactory.

Mr. F. R. SHEPHERD (Antigua) : I have tried dipping cuttings in tar in Antigua and was satisfied with the results. I coated both ends of the cuttings.

The Hon'ble F. J. CLARKE (Barbados) : I dipped about 2,000 to 3,000 plants in tar this year, being careful to have both ends sealed up with the tar, and planted them in a field alongside others not so treated. Whether it was that I allowed too long a time (twelve hours) to elapse between treating and planting, I do not know, but I did not see any difference between those treated and those not treated.

The PRESIDENT : Was the tar liquid?

The Hon'ble F. J. CLARKE : Quite liquid, but it was not mixed with anything.

The Hon'ble SYDNEY OLIVIER (Jamaica) : Did the plants which died after being treated and planted, die of fungus?

The Hon'ble F. J. CLARKE : I do not know. I did not have them examined.

The Hon'ble F. WATTS (Leeward Islands) : I think the result of previous experiments with soaking cane plants in Jeyes' fluid has been obscured from want of knowledge. In Antigua we soaked the plants in a solution of Jeyes' fluid as a protection against rind fungus. Mr. Howard, in this paper, which is I think most valuable, has shown that the plants were attacked by a fungus we were unaware of and in a manner we did not expect. Finding from our Antigua experiments that we did not effect a diminution of the rind fungus we thought the method unsuccessful : but under the light thrown upon the question by Mr Howard, I think we shall have to renew the experiments. By following out his suggestions we may secure an immunity from an enemy of which we were not previously aware. Mr. Howard has said that certain canes grew after being infected with this pine-apple fungus. I should like to ask him whether they grew and resisted the attack, or whether they grew for a certain time and then died.

Mr. HOWARD : With reference to Mr. Shand's remarks about the greater germinating power of untreated tops than that of cuttings it would be desirable, I consider, to protect tops as well as cuttings.

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* Dr. NICHOLLS has since communicated an account of the methods employed in Guadeloupe from which it appears that diseased cane-tops were simply soaked in tar water for twelve hours before planting.—(ED. W. I. B.)

With regard to Mr. Clarke's experiments, there is every danger of the cuttings being infected if left even one day between the time they are cut and treated. If the cuttings are dipped in Bordeaux mixture as soon as they are prepared infection is practically impossible and they may be left in the yard for a day or so without any great risk. The value of the treatment is more likely to be evident in a dry season than during a favourable period like the present.

In reply to Mr. Watts, the experiments have shown that in the majority of cases when cuttings have been treated with Queensland solution, lime-wash, or soaked in water, and spores of the fungus placed on the cut ends, the cuttings have commenced to grow but have not been able to develop far enough for the shoots to grow from their own roots. The fungus has destroyed them before they could do this. In some cases, however, when the conditions were exceptionally favourable for the cuttings, the young shoots have developed far enough to grow from their own roots and then have become independent of the cuttings although the fungus has been present. The cutting has, in this case, won the race. The essence of the treatment consists in helping the cutting to withstand the fungus long enough for the buds to grow into independent shoots. When this is realised the canes grow normally and healthily, no matter whether the fungus is in the old cutting or not.

The PRESIDENT: I should like Mr. Howard to place before the Conference in what manner he considers the cane tops to have been infected by the fungus. Is it possible for them to be infected when lying, as they often do, in the estate yard, before planting; or are they infected, after they are planted, by spores finding access to the exposed portions of the cane top in the field?

MR. HOWARD: In reply to the President, I think infection takes place both in the estate yard before planting, especially when the cuttings are in heaps: and also in the fields where they are planted.

THE LADYBIRD OR WEEVIL BORER OF SUGAR-CANE.

(*Sphenophorus sericeus*, Oliv.)

BY H. MAXWELL-LEFROY, B.A., F.E.S.,

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At the last Conference, a short account was given of the insect-pests of the sugar-cane, and among them of the Lady-

bird or Weevil borer, *Sphenophorus sericeus*, Oliv.* More recent investigation has cleared up many doubtful points and the life-history and methods of attack of this pest are now better known.

LIFE-HISTORY.

The life-history may be summarized thus: The eggs are laid singly, embedded in the cane to the depth of one-sixth of an inch. The egg is oval, about one-fifteenth of an inch in length and almost transparent. It hatches in four days to a small white grub which eats its way into the cane. A small tunnel is formed, increasing in diameter as the grub grows larger. Growth is at first slow, the grub attaining about half its size in five weeks whilst fully grown in about seven weeks. It has by this time destroyed a large part of the interior of a joint of cane and makes a round cocoon of the long fibres which it has not eaten. In this cocoon it passes the chrysalis state, lasting about ten days, and then emerges as the fully formed beetle through the end of the cocoon. The beetle is active, flying about at night, feeding on cut or broken canes, and other food of a similar nature (for example, the cut end of palm stems). After mating, the female lays eggs, each egg being deposited singly: egg-laying is continued for a considerable time and the beetles may be kept alive for several weeks.

The eggs are laid in cut or broken canes, and in the soft part of the cane above the hard joints. The beetle appears to be unable to penetrate the hard rind of a mature joint of cane, but wherever it can pierce the surface and reach the soft inner part of the cane, it will lay eggs.

MODE OF ATTACK.

The grub is to be found in growing canes, in broken or cut canes in the field or yard, in plant canes in the ground and in ratoon stumps. In all these situations the insect is destructive. The number of canes infested by this insect that are found in the yard at crop time is sometimes very large, and more canes are left in the field when reaped, as they are not worth picking up and bringing in. If the attack commences in time, practically the whole interior of the cane may be eaten out, leaving only the rind with a mass of fibres and 'frass' inside. Cases have also occurred where the growth of the young canes from cane plants has apparently been checked by the destruction of the cane plant by these grubs. Where cane tops are planted with one end above the ground, or exposed on the surface, the beetles are likely to lay eggs; and as the attack of the grub commences in four days, damage will probably be done to the young growing canes.

In the case of ratoon stumps, it is not certain whether the 'springing' of the young canes is checked by the ravages of these grubs. Ratoon stumps are constantly attacked: of several hundred stumps of canes which had been cut for plants

* *West Indian Bulletin* Vol. II, p. 41.

in December 1900, not one could be found free from these grubs, and wherever ratoon stumps have been examined in Barbados, grubs have been found.

The damage caused by this insect consists in the destruction of canes growing in the field, injury to young canes springing from cane plants, and possible injury to young canes springing from ratoon stumps.

REMEDIES.

The remedies for the lady-bird borer are, in the main, very simple. The first has been urged constantly both for moth borer, weevil borer, and also for fungoid diseases, viz: *Destroy all rotten or infested canes.* The practice of keeping canes infested with weevil borer grubs in the yard or leaving them in the field, is calculated to assist the increase of this pest to the greatest extent possible. Those who do this are deliberately preserving and assisting an insect whose ravages might become very serious.

The second remedy is to cover the ratoon stumps with mould as soon as possible after the canes are cut. In this way the beetles will be unable to lay eggs in the ratoon stumps and so the increase of the pest will be checked.

The third is to destroy all ratoon stumps not intended to be grown, within six weeks from the time of cutting. I have frequently seen large fields of stumps, which were not intended to grow, and were full of this insect. Had these stumps been dug up and burned, an enormous number of the insects would have been destroyed, and thus one method of adding to its numbers would not have been possible.

The last recommendation is to cover the cane plants in the ground with mould, or at any rate, to plant them in such a way that the cut end is not exposed above the surface. There is then little chance of the beetle finding the cane or being able to reach it to lay eggs. Doubtless Mr. Howard's recommendation* to tar the ends of cane cuttings would prove effective in this case.

The above recommendations aim at preventing the attack, and lessening the numbers of the insect by depriving it of its breeding places. Direct remedies, attempting the actual destruction of the insect, are possible only by destroying rotten canes and infested stools. The chief reliance must be placed in preventive measures and those indirect actions which tend to lessen the insect's numbers.

These recommendations, if practically carried out, should prove effective in a short time. A few seasons' vigorous work, entailing but little alteration in present estate practice, should see this pest and its ravages much diminished, and these islands rid of an insect which, next to the moth borer, is at present the most to be feared by sugar planters.

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* See *ante* p. 81.

DISCUSSION.

The Hon'ble F. J. CLARKE (Barbados): I should like to ask Mr. Lefroy whether the ladybird borer is the white grub often found at the bottom of a cane stump when the canes are apparently withering. The suggestion to cover with mould the stumps intended for ratoons is impracticable owing to want of sufficient labour, neither can we do it with a plough because the ground is covered with trash.

The PRESIDENT: Could you put the trash on?

Mr. CLARKE: Then we should kill the stump. With regard to cane plants dying after having germinated, I have searched many such dead plants in my day but have never found the ladybird borer.

The Hon'ble C. A. SHAND (Antigua): Covering the cane stumps with mould is carried out to a considerable extent in Antigua, where the practice is when a field is cut down to range the trash on every other bank and then split each side of the bank left uncovered with the plough, throwing the mould over the stools from which the canes have just been cut. This is done not only in fields in which the cane has been planted in the furrow, but also in land that have been cross-holed. In Louisiana I believe after the canes have been cut a machine for cutting down the stumps very close to the ground is used, but of this I have had no personal experience. It is obvious that such a machine could not be utilised in cane land that had been cross-holed.

The Hon'ble F. WATTS (Leeward Islands): We are very grateful indeed to Mr. Lefroy for giving us the life-history of the ladybird borer and showing us how to deal with this pest. With respect to the habits of the beetle, Mr. Lefroy's investigation does not accord with my experience on one point. The beetles I kept in captivity always went down and spent a considerable portion of their time under the soil. I was of opinion that they were laying eggs during that period but apparently was mistaken. I think that the remedies suggested by Mr. Lefroy are practicable, especially that of covering the stumps with mould.

Mr. LEFROY: In reply to Mr. Clarke I would like to point out that this grub is constantly confused with two others, known in the West Indies as the 'hardback' and the 'root-borer.'

The hardback grub is the grub of the common beetle, *Ligyrus tumulosus*: it lives in the ground feeding on decaying vegetable matter.

The root-borer is the grub of an unknown beetle which also lives in the ground and feeds on the roots of cane, sweet potato and other plants, frequently boring into the underground base of the cane. It is distinct in structure and habits from the grub of the ladybird borer, and never enters the cane except from *below the surface* of the ground.

These three grubs are easily distinguished: The hardback grub has three pairs of legs; the weevil-borer grub has no legs,

but the hind end of the body is very much swollen into sort of hump by which it pushes itself along its tunnel in the cane: the root-borer grub has no legs and no hump, but is thicker behind the head than at the hind end of the body. It is important that we should keep these three insects and their work clearly separate.

With regard to Mr. Watts' experience of this insect, I found that the beetles would enter the ground only when it was very dry and when there was no other shelter. During the day the beetles habitually shelter under trash and emerge in the evening to seek for food. But in my experiments, I was never able to induce the beetles to penetrate the soil to a depth of half an inch even when pieces of sour cane were buried at that depth and the beetles were practically starving. They will go far enough into the soil to be just covered by mould when no other shelter is available but I found that canes with half an inch of dry mould over them were safe from the attacks of the beetle.

Mr. J. H. HART (Trinidad): Mr. Lefroy mentioned several Colonies in which the ladybird borer is found, but omitted Trinidad. I have seen it in Trinidad but never abundant or doing any special damage. Perhaps Mr. Fenwick may be able to say whether it has ever done much harm in Trinidad.

Hon. G. T. FENWICK (Trinidad): The only instance I can recollect of damage being done by a root-grub in Trinidad was at El Soccoro Estate, near Port-of-Spain, about twenty years ago. Some 200 acres of canes were in a few weeks entirely destroyed by a grub about one and a half inches long as thick as the little finger and of a bluish-grey colour. Twenty to fifty of these grubs were sometimes found in the roots of a cane stool. The grubs did not attack the stems above ground.

The PRESIDENT: One of the advantages arising from the organisation of the Imperial Department of Agriculture is that it is now possible to employ specialists confining their attention to definite points with a wide range of knowledge and experience of the West Indies. These officers are regularly on tour collecting material and carrying on investigations. They have, in addition, well equipped laboratories, and works of reference at hand.

It is desirable for those who meet with discouragment and difficulties in agricultural matters to send specimens and communicate either directly with the Department or through the local officers.

While it is impossible for the specialists to visit every locality in these Colonies, there should be no difficulty in forwarding specimens for examination and for these to be reported upon without delay. The specimens I may add, should always be accompanied by the name and address of the sender and by a full statement of the circumstances in each case.

THE ORGANISATION AND FUNCTIONS OF BOARDS OF AGRICULTURE.

The Hon'ble SYDNEY OLIVIER, C.M.G., (Jamaica): I shall be extremely brief on this subject. In 1900, nearly two years ago, the Board of Agriculture of Jamaica was first instituted. Proposals had some years previously been under consideration for the institution of an Agricultural Department of the Government with a Director of Agriculture, but that was not found practicable. The Colony had neither the money nor the man for an Agricultural Department with a Director at the head. But they had already existing several very valuable organizations and several very efficient Government Departments which they have now combined into one body known as the Board of Agriculture. The Board has the Colonial Secretary as Chairman. In this way all its functions are brought under the immediate cognizance of the Government, and promptly put into practice. In British Guiana a similar body has recently been established with the Government Secretary as Chairman. For general purposes of business it is unquestionable that when a Colony has a Colonial Secretary whom the Board of Agriculture can regard as a sufficiently competent Chairman it is a distinct advantage to have him in that post. On the Board of Agriculture of Jamaica we have the Director of Public Gardens and Plantations: the Commissioner of Agriculture for the West Indies (Dr. Morris) who, however, can not visit the Colony more than once a year, if so often: and the Government Chemist. In Jamaica the Government Chemist, until recently, was simply a Government analyst making analyses for the purpose of criminal prosecutions under the Adulteration of Food and Drugs Act. During the past four or five years he has been gradually turned into an Agricultural Chemist, and his department has been very much strengthened. He has been given an assistant from England and another local assistant, and the Government are building a new laboratory adjacent to the Botanic Gardens and Experiment station which would be capable of affording accommodation for dealing not only with matters relating to criminal prosecutions, but with the increasing amount of agricultural work which now devolves on the Department. There are on the Board four members selected by the Governor, namely, his Grace the Primate of the West Indies, and Mr. J. V. Calder, one of the foremost agriculturists of the island, a gentleman who has distinguished himself as a planter of cacao as well as sugar and is a thorough representative of the general agricultural industries of the Colony. There is also Mr. DeMercado, one of the principal exporters, and a very important man in the mercantile community. Then comes Mr. Shore, a sugar planter, who represents a special class of sugar estates in Jamaica. Two other members are appointed by the Governor on the nomination of the Agricultural Society of Jamaica, an unofficial organization of the very greatest importance, and thoroughly representative. It consists of a central board of management and has affiliated to it a great number of local societies, which are in correspondence with

the main Society and organise shows in their own districts.

The Board of Agriculture in no way interferes with any work already being done by pre-existing organizations. There was a little jealousy at the beginning as to whether the Board of Agriculture would not interfere with the work of the Agricultural Society. But this result has not been brought about. They are now working in harmony, and I think the Board has been able to get from the Agricultural Society from time to time useful hints as to what should be done by executive action on the part of the Government. Mr. Craig and Mr. Sharpe are the two gentlemen who represent the Society on the Board, and the latter was a delegate to the last Conference. The Agricultural Lecturer appointed by the home Government, and a member of the Imperial Department of Agriculture, is Secretary of the Board, which is thus brought into touch with the instruction of elementary school teachers. The Chairman of the Board of Education is also a member of the Experiment Station Committee of the Board of Agriculture. On the whole the Board is a very strong and active body and has thoroughly justified its existence. One or two very useful things have been the outcome of the efforts of the Board. It has, with the approval of the agricultural community, managed to get an Order passed in Council for fumigating plants. It has been able to get a Bill passed preventing the adulteration of fertilizing stuffs, such as is on the Statute Book of Barbados. The Board supervises all the work on agriculture in the island and has been able to bring about a considerable amount of economy in many directions. It has* developed the work of the agricultural instructors. It has been able to arrange with planters for experiment stations. The members of the Board are divided into sub-committees who see after experiments of every description, the instruction of elementary teachers, lectures, and the carrying on of the several industries. Under the Board the utility of the Experiment stations has been increased. By the presence of this Board we have been able to dispense with a certain amount of purely botanical work at one of the gardens in the interior of the island. In short the Board is endeavouring to effect economy wherever advisable, and at the same time to promote the agriculture of the whole island. I do not think this could be done in Jamaica by any organization except such as we have in the Board of Agriculture. Since this Board has been organised the island has made a great deal more progress in agricultural education than in any like period in the past. I am extremely gratified with the results of the Government's efforts in forming the Board, and the co-operation and stimulus given to everything connected with agriculture in the island. British Guiana has followed in the footsteps of Jamaica in this matter, and I cannot help thinking that such an institution in Trinidad and other Colonies would prove of great advantage. (Cheers.)

Professor J. B. HARRISON, C.M.G., (British Guiana): The Board of Agriculture of British Guiana has not long been brought into existence. The Government Secretary is Chairman of the Board, the Immigration Agent-General, the Inspector of Prisons,

the Inspector of Schools, the Government Analyst, the Government Botanist and the Government Veterinary Surgeon are the official members, and the Hon'bles B. Howell Jones, R. G. Duncan and C. P. Gaskin. with the Rev. F. C. Glasgow, Mr. R. Evans (Curator of the British Guiana Museum), and Mr. F. J. Seard (Chairman of the Agricultural and Commercial Society) form the unofficial section. The Revd. F. C. Glasgow is a gentleman who is in very close touch with the smaller settlers and farmers and takes very great interest in the work of the Board.

The principle upon which we are working is to hold comparatively few meetings of the Board at which but little talking takes place or discussion is necessary, as the main work is accomplished by circulating papers to the members each of whom expresses his views in a few written words thereon. Hence matters, are, as a rule, ripe for settlement before being brought up at the general meetings of the Board.

The detailed work of the Board is carried on by small sub-committees of which at the present the following have been appointed:

No. 1. Finance Committee.
No. 2. Correspondence Committee.
No. 3. Publishing Committee.
No. 4. Experiment Stations Committee.
No. 5. Library Committee.
No. 6. Education Committee.
No. 7. Exhibitions Committee.
No. 8. Sugar-cane Experiment Committee.
No. 9. Stock Committee.

Correspondence and other matter relating to any particular subject are received by the Secretary and after registration, etc., passed on to the Deputy Chairman, upon whom the general working of the Board devolves and who is also *ex officio* Chairman of Committees. The Deputy Chairman circulates the papers either among all the members of the Board or more usually, among members of the special committee most closely concerned with the subject. The papers are returned, after circulation, to the Deputy Chairman who summarises the views expressed and passes them on. through the Secretary, to the Chairman. The latter decides either that the matter under consideration is sufficiently ripe to be brought up at the General Meeting of the Board, or directs that the papers be circulated to the general members. For general circulation the papers are submitted by the Deputy Chairman (the Government Analyst), first to the technical experts on the Board and afterwards to the other members.

The Board is quite young - it has only just commenced to work—but I hope some day it will have as successful a record as that of the Board of Agriculture of Jamaica laid before the Conference to-day. I think the members of this Conference will recognise that dealing with such important subjects as those indicated by the titles of the sub-committees and having to extend gradually their operations over the great area of the

Colony--some twenty-five times that of Jamaica—the members of the Board of Agriculture of British Guiana will find plenty to occupy their energies. How far their efforts will meet with success I cannot say, but the Commissioner of Agriculture is an Honorary member of the Board and it is hoped that he will willingly assist the members in their endeavours and enable them to do more than they are doing at present. The members of the Board look eagerly forward to that future day when they will be able to welcome Dr. Morris to his seat among them.

The Hon'ble G. T. FENWICK (Trinidad): In Trinidad the Agricultural Society although not created by Ordinance is working on very similar lines to those described by Mr. Olivier. The Governor is Chairman and the Government Botanist and the Government Analyst are *ex officio* members. Amongst the members are the Attorney General, the Auditor General, the Director of Public Works, the Principal of the Training College and the Sub-Intendant of Crown Lands. The agriculturists of the Colony are thus brought into touch with the Governor and almost every Department of the Government, and in particular with the Executive and Educational Officers.

REPORT OF THE CHEMICAL SECTION AT THE CONFERENCE OF 1902.

The Chemical Section was founded in 1901, to deal with technical questions that could not be profitably discussed in open Conference.

At the Conference of 1902 the following members were present: -

Professor J. B. Harrison, (British Guiana), Chairman.

The Hon'ble Francis Watts, (Leeward Islands).

F. J. Scard, Esq., (British Guiana).

J. R. Bovell, Esq., (Barbados).

W. R. Buttenshaw, Esq., (Jamaica).

Professor J. P. d'Albuquerque, (Barbados), Secretary.

The Members of the Section first of all requested their Chairman to convey to Dr. Wiley, as American Representative of the International Sugar Commission, their adhesion to the standard method adopted at the Paris meeting of the Commission in June, 1900.

The Section then took up the consideration of the following points submitted for consideration by Messrs. Harrison and Scard :—

(1.) A method for determining the proportions of naturally occurring sugar-cane glucose and those of dextrose and levulose produced by inversion during manufacture which may be present in residual molasses.

(2.) The determination of the nature of the so-called 'gums' and other pectinoid bodies which may be present in the normal or in the abnormal juices of the sugar-cane, and to suggest methods for their quantitative determination.

(3.) The possibility of formulating a definite relationship between the glucose ratio and the quotient of non-sugars in the expressed cane-juice and the commercial recovery of muscovado sugar therefrom.

(4.) The effect, if any, of manures on the normal period of ripening of various varieties of sugar-cane.

(5.) The effect of flooding the land, on the conservancy of plant food in the soil.

(6.) The causes and prevention of the occurrence of factitious 'faultiness' in coloured rum.

After some discussion it was agreed :—

(1) & (2.) That the points raised in paragraphs (1) and (2) should be investigated, as opportunities occur by members of the Section who would report results at subsequent meetings.

(3.) There is at present no possibility of formulating a definite relationship between glucose ratio and quotient of non-sugars in the expressed cane juice and the commercial recovery of muscovado sugar: the solution of this question hinges upon the investigation recommended under (1) and (2.)

(4.) While the Section expresses no final opinion upon this point, it is strongly of opinion that the bulk, at all events, of soluble nitrogenous manure should be applied early in the active period of growth. There appear to be a tendency on the part of planters to retard the application of nitrogen with detrimental effect to the normal ripening of the canes.

(5.) Mr. Scard mentioned that a common method in British Guiana and Surinam of restoring the fertility of heavy clay lands that have become unproductive through exhaustion of humus, is to flood them for a succession of periods of three weeks or more, and that he could not reconcile this with the commonly accepted theories of nitrification. It was pointed out that this is somewhat analogous to the effect of flooding rice

lands and it was felt by the members of the Chemical Section to be a subject worthy of future investigation The flooding was not a process of either warping or sewage irrigation as clean bush water (practically rain water) was employed

(6) It is essential in the opinion of the Section in testing rum for faultiness that the samples after dilution (or breaking down) should be placed in closely stoppered bottles

AGRICULTURAL CONFERENCE, 1902.

(CONTINUED.)

THE TEACHING OF AGRICULTURE IN THE WEST INDIES.

The results of efforts during the last three years to introduce the teaching of the principles of Agriculture in the Colleges and Schools in the West Indies.

JAMAICA.

MR. A. B. McFARLANE (Superintendent of the Mico Training College, Jamaica): In the following paper I shall endeavour to give a brief account of the training in agriculture that is being given to students in the regular course of instruction at the Mico Training College, Kingston, Jamaica, of which institution I have the honour to be Principal, and to supplement that by what has come under my own observation in regard to the special courses given to teachers who are already in charge of elementary schools, and who hitherto have had little or no opportunity of studying agriculture on the most approved methods.

There are seventy-six students in residence at the College, of whom sixty-four are from Jamaica and the remainder from the Leeward Islands. All of them have had a regular course of training in agricultural science by Mr. Buttenshaw of the Imperial Department of Agriculture. Four lectures a week have been given throughout the year, and the instruction is based on the following syllabus, from which the minor details have been omitted:—

SYLLABUS OF WORK.

(1.) A course of elementary physics and chemistry, preparatory to the study of the life and food of plants and to a knowledge of the composition of soils and manures.

(2.) The composition of the atmosphere.

(3.) Soils: their origin and formation, constituents and properties.

(4) Plant structure: root, stem, leaf, flower, fruit and seed.

(5.) Plant life: germination, nutrition, storing of food, chemical composition of plants.

(6.) Cultivation: tillage, draining, irrigation, manuring.

(7.) Crops.

(8.) Box gardening.

A similar course of instruction has been given by Mr. Buttenshaw to the students of the female colleges, viz:—Shortwood, Bethlehem and St. Joseph's, about sixty students in all.

Each lecture is illustrated by numerous experiments, many of which have been prepared by the students themselves. While some of the experiments are of such a nature that they cannot be made use of by elementary teachers owing to their inability to secure comparatively expensive apparatus, yet, great care is taken to employ, in addition, such illustrations and practical experiments as can be provided at little or no expense and can be made use of in the ordinary elementary schools of the island. Each lecture is followed by viva voce questions to test whether the subject-matter has been fully grasped. In addition to this, the students are required to give object lessons, based on the instruction they have received from Mr. Buttenshaw, as well as on subjects dealing with the ordinary phenomena of common life, and with objects familiar to school children.

TRAINING TEACHERS TO GIVE OBJECT LESSONS.

As such object lessons are of great value in teaching children to observe, and by this means of quickening their general intelligence and of leading them to take an intelligent interest in the various processes of nature, I propose very briefly to sketch the plan adopted in the College to ensure that the lessons to be given to children by the students when in charge of schools shall conform to proper pedagogic methods.

The student about to give an object lesson is required to write full notes of the proposed lesson, and to supply himself with the 'object' itself and with suitable illustrations. A class of children is taken from the practising schools in connexion with the College, and the lesson must be given in the presence of the whole staff, and students, all of whom are supplied with note-books in which their criticisms are entered under various heads, such as, notes, subject-matter, method, the teacher, illustrations, use of black-board, etc. After the class has been withdrawn, two or three students are called upon to read their criticisms under one or more of the above heads. The members of the staff also criticise the lesson; the Principal sums up the criticisms and marks are awarded. The books are collected and scrutinized. It will thus be seen that an attempt is made to discourage the pernicious system of cramming with

book-knowledge in order to pass an examination, a system that is far too prevalent in Jamaica as well as in other parts of the world. Last year the work in agricultural science was examined by an Inspector of the Education Department, and the following extract is made from the report recently issued by the Superintending-Inspector of Schools:—'The papers on agriculture worked at the Training College examinations showed an intelligence and grasp of the subject that I have looked for altogether in vain before. Mr. Buttenshaw's lectures have done good work, and I have no doubt that still better work will be shown next year through a better foundation existing in the work done in 1900.'

Box-gardening on the lines suggested in the French scheme of agriculture has received due attention throughout the year, and the students have gained an intelligent knowledge of the *Tropical Readers.*

PRACTICAL OUT-DOOR WORK.

For the past few years all the men entering the College have been required to devote a certain number of hours each week to horticultural work on a portion of the grounds set apart for the purpose. The area at present under cultivation is about one acre and there is ample room for its extension should the need arise. So far as site and aspect are concerned the position is in every way desirable, but the land itself was in the very poorest condition. The good original surface soil had been gradually worn and washed away and the exposed subsoil was stiff and stony. By constantly turning up the soil and by the addition of some hundreds of loads of stable litter, the larger portion is now in good tilth and yields satisfactory crops of both fruits and vegetables. A small corner of the ground has been left in its original condition as an object lesson for those who may come after, as well as for those who have contributed by their labour to bring about the results mentioned. At first there was some considerable dislike on the part of the young men generally to the heavy manual labour that the work necessitated, but, as the results became evident in the changes brought about, their interest became very real.

The Directors have provided ample supplies of the best horticultural tools, and a very important point in the teaching has been to bring out clearly that satisfactory results depend as much upon the method of cultivation and the right employment of the best implements as upon, perhaps, any other part of the work. The students have been taught the names and uses of the various implements. The time given to the work covers generally from six to eight hours per week on four days in the week. The men are taught in groups, but the work is so arranged that each man is taken through each stage of the work, such as raising vegetables from seed, transplanting and carrying on each successive stage to maturity.

Vine culture has also had considerable attention and over twenty varieties are in cultivation. These have been raised by the students from cuttings originally received through the courtesy of the Secretary of the Royal Horticultural Society's

Gardens at Chiswick. All the best table grapes are included in the selection as well as some varieties which are less known and more difficult to grow. These are kept by way of experiment and to test their adaptability to the climate in the hope mainly of finding a variety that will succeed in the hill districts. The men are all taught how to propagate from buds and cuttings and carried through all the varied stages of vine culture, such as pruning, disbudding, thinning both vines and clusters and the after treatment necessary to secure ripe wood for next year's crop, whilst maturing the crop for the current year. Any of the men who have gone through this course should be able to superintend successfully, and to give practical lessons in gardening and fruit culture in any ordinary day school.

Satisfactory crops of vegetables, such as tomatos, peas, and beans of all kinds (except scarlet runners and Windsor beans, both of which failed entirely), beetroot, carrots, cabbage and turnips, have been grown as well as large crops of grapes, all of which could have readily found a market. Bananas have been planted in the same soil at the same time, and then subjected to different methods of treatment, from entire neglect to high culture, and the wonderful differences in the results have been pointed out.

Quite a number of fruit-trees, forming a sort of orchard, and consisting of oranges, mangos, cashews, akees had been nearly destroyed by fires made by the carpenters engaged on the work when the College was being built. These were almost reduced to naked stumps. The students took them in hand, the ground was lightly forked over, a plentiful supply of wood ashes with some basic slag was dug in, and the ground received periodical soakings of water in dry seasons. The trees are now the picture of perfect health and bear fruit abundantly. The reason for every step of the work is given to the students and what the result is likely to be, and so an intelligent, steady interest is maintained throughout. This practical work is under the superintendence of the Reverend Wm. Griffith, one of the Directors of the College.

In addition to this, batches of the students are required daily (except in wet weather) to assist in weeding and keeping clean the twenty-three acres of land surrounding the College buildings. Many of the Jamaican students take much interest in this work. Others, especially some of those from Antigua and the neighbouring islands, have not yet learned to look upon such work with a kindly eye.

INSTRUCTION AT THE GOVERNMENT GARDENS.

During the past year a very great privilege has been extended to the third year students, and to the second year students from the Leeward Islands—about forty in all—through the kindness of the Hon'ble Wm. Fawcett, Director of Public Gardens. For two hours every Saturday morning throughout the year a batch of twenty of them has been through a thorough course of practical training in agriculture, such as could be obtained nowhere else in Jamaica, at the Government Gardens at Hope. The Gardens are situated at a distance of between four and

five miles from the Mico College and the students were conveyed to and fro in the electric cars. The instruction was of a very varied and valuable nature, and those who attended the course are very grateful to Mr. T. J. Harris, their teacher, and to Mr. Fawcett for his kindly interest.

From the foregoing sketch it will be seen that very thorough instruction in agriculture, based on sound scientific knowledge, is being given to the training college students.

VACATION COURSES FOR TEACHERS.

In order that teachers already in charge of schools shall have the opportunity of obtaining similar, though necessarily more limited instruction, courses have been held during part of the summer vacations of the past two years.

Thirty-six teachers attended the first course which lasted for three weeks. Through the kindness of the Rev. Canon Simms, the Jamaica High School, which is in close proximity to Hope Gardens, was placed at the service of the Education Department and the teachers were boarded and lodged there. The Directors of the Mico College supplied bedding, linen, cutlery, etc., and the whole of the arrangements for this course, as well as for that of the following year, were placed under my superintendence. The general scheme of work was as follows:—

Practical work at Hope Gardens, daily from 7 to 9.30 a.m.

Lecture by Mr. Buttenshaw on elementary physics and chemistry, 11 to 11.45 a.m. Lecture by Mr. Buttenshaw on plant life and growth, 12 to 12.45 p.m. Lecture by Mr. Buttenshaw on soils, 1.15 to 2. p.m.

These lectures were given on five days of each week and the teachers asked questions on matters that required further explanation at the close of each lecture. A very valuable lecture was given by Mr. DeMercado, one of the leading merchants of Kingston, on the preparation of produce for market. Mr. Burnett gave some excellent talks on bee-keeping.

At the request of the teachers two lectures, illustrated by the magic-lantern, were given by me on some of the great cities of Europe and of the East which I have had the privilege of visiting.

This pioneer course was very successful. When it was known that a similar course would be held during the following summer more than two hundred teachers applied for permission to attend.

The Hon. S. Olivier, who was the Acting-Governor at the time, invited the teachers to tea at King's House grounds, a precedent which was followed by his Excellency Sir Augustus Hemming last July. The kindly thought which prompted such action was highly appreciated by the teachers.

In July of last year a similar, but more extensive course, lasting for four weeks, was held at the Mico College which was lent for the purpose by the Directors, and is admirably adapted for the accommodation of a large body of men. Over sixty

teachers were present, fifty-eight of whom received board and lodging on the premises. Practical work was done at Hope Gardens as in the previous year, and Mr. Buttenshaw gave three lectures a day throughout the month.

The teachers assembled on the first of July and were addressed by the Hon. S. Olivier, Chairman of the Board of Agriculture. The Hon'bles Thos. Capper and Wm. Fawcett were also present. Mainly through the instrumentality of Mr. Olivier, who took the deepest active interest in the whole of the course and encouraged the teachers by his presence and advice on frequent occasions, the following afternoon lectures, which were open to the public, were provided:

Irrigation	Hon. S. Sharp.
Bee-keeping	H. G. Burnett, Esq.
How Jamaica was made	Hon. S. Olivier.
The preparation of produce for market	C. C. DeMercado, Esq.
Plant societies	Hon. Wm. Fawcett.
Poultry	J. Barclay, Esq.
The water we drink	H. H. Cousins, Esq.
The teaching of elementary science in schools	Rev. Canon Simms.
How to make the most of small holdings without borrowing capital ..	Hon. H. Cork.

In order that the whole time of the teachers should be profitably employed several lectures illustrated by magic-lantern views were delivered by Mr. Cundall and myself on subjects of special interest to the teachers, and lessons in hand-and-eye training were given by Mr. Skyers of the Mico Practising schools.

In the following August a course was held at Bethlehem in St. Elizabeth. Nineteen teachers attended and they were required to make their own arrangements for board and lodging, a special grant being given by the Government to each man. Mr. Buttenshaw lectured, and the practical work was in the hands of Mr. T. J. Harris of Hope Gardens and Mr. Palache. That the teachers intended to put their instruction to some practical purpose is evidenced by the fact that all of the tools taken to Bethlehem, to the value of £15, were purchased and there was not a single teacher who did not purchase one or more of the tools.

In each of the courses the teachers spent a very profitable and enjoyable time. Before leaving they presented addresses expressing deep gratitude for the instruction they had received and for the care that had been taken to provide for their comfort. With few exceptions they conducted themselves admirably throughout. The feeling, that many of them had a year or two ago, that agricultural work was not on so high a level as some of the book studies in which they were engaged is gradually dying out, and the Imperial Department of Agriculture is to be congratulated on having commenced the teaching of agriculture in Jamaica on the right lines. I must confess that these experiments have succeeded better than I anticipated and public opinion in Jamaica is on the side of continuing such courses of instruction.

Mr. Buttenshaw who has had many opportunities of seeing the work that is being done in the country by teachers who have attended these classes, and who is far more competent than I of gauging the value of such work, will, I understand, tell us some of his experiences. Mr. Capper would be glad if arrangements could be made to extend the advantages of such training to a larger number of teachers, but, as Mr. Buttenshaw's time is so very fully occupied at present, there seems little likelihood of this being done. An important step has been gained, people generally are beginning to realize that the prosperity of Jamaica depends upon the proper use made of its soil, and in order that the coming generation may grow up in the knowledge of how to obtain from the soil those products which are required in the various markets of the world I am convinced that no wiser course could have been adopted than that of first giving this instruction to the teachers in charge of elementary schools.

Mr. W. R. BUTTENSHAW (Lecturer in Agricultural Science, Jamaica): In the paper just read on the training of teachers in agriculture, Mr. McFarlane has described what is being done in Jamaica to equip the teachers to give instruction in the principles of agriculture in the elementary schools. I shall now endeavour to indicate some of the lines along which we may expect useful results to follow this work. It must not for a moment be thought that I am making the mistake of looking for results, at this early period, from the introduction of the teaching of agriculture into the elementary schools; but, there are already in Jamaica unmistakable signs of the stimulating effect of this agricultural training, and it will be found that influence is spreading from the teacher to the small settler, even if not through the medium of the children.

TEACHERS AS SMALL CULTIVATORS.

While the preliminary object of the training is to make the teaching in the schools 'more consonant with the environment of the scholars' and so train up a peasantry with a more intelligent interest in agriculture, yet other results may, I think, be looked for more immediately. These will follow from the teachers' personal connexion with agriculture. As very few of the teachers in Jamaica have to spend more than four days a week in the schools, it is found that a large proportion of them—probably eighty per cent.—work 'grounds' of their own. This fact undoubtedly accounts for much of the keenness evinced by the teachers who attended the agricultural lecture courses. Mr. Capper, at last year's Conference, referred to this keenness as being due largely to a desire to make practical use of the knowledge so gained for their own private benefit. On account of the imitative spirit shown by the small cultivator, any improved methods adopted by the teacher as a result of the training will have an effect on the agriculture of his district.

INTRODUCTION OF NEW TOOLS.

It is pleasing to notice, however, that some of the teachers

have not been content to rely simply on this imitation on the part of the settler, but are doing their best to assist their neighbours by giving practical demonstration of the advantages of more scientific methods and the wastefulness of some ordinary practices. As an example of the good that can be done, the introduction of new tools might be mentioned. No one will deny that one thing that is most urgently needed in the West Indian islands is the substitution of the fork and spade for the hoe and cutlass in many practical operations.

It has been interesting and instructive to watch the attitude of the teachers towards these tools in their lessons in practical agriculture. While some have been already well acquainted with, say, the spade and fork, to many these tools have been quite new and their usefulness has come frequently as a revelation. Of the teachers who attended the course of instruction held last summer at Bethlehem not one went away without tools of some sort, as has been stated by Mr. McFarlane. This cannot but result in a much more general use of these tools, and there can be no doubt that with our naturally fertile lands, more thorough tillage is what is needed to secure better returns. While there may perhaps be some slight danger of the teacher posing as an agricultural expert, good must follow any efforts, however humble, towards improving the cultivations of his neighbours. The work of the teachers as agricultural missionaries promises to be most valuable. It is already noticeable in the efforts of the local Agricultural Societies of which the teachers are frequently officers and leading spirits in the promotion of agricultural shows and other useful work. In a recent report to the Board of Agriculture, the Travelling Instructor bore evidence to the interest taken by the teachers in agricultural affairs and stated that at one meeting he noticed no fewer than thirteen teachers present.

LECTURES TO TEACHERS' ASSOCIATIONS.

During the last six months I have had numerous opportunities, by reason of lectures to the Teachers' Associations, of observing the effect of this training upon the educational work of the teachers. It will easily be understood that with over 800 teachers in Jamaica some time must elapse (as Mr. Capper pointed out last year) before all of them will have received instruction in agriculture. With a view, therefore, to assisting those who have not attended the courses of instruction I have been giving lectures at various centres to the Teachers' Associations. Of these associations there are some thirty-five with an average membership of about twenty, holding meetings usually once a month to discuss matters relating to their work in the schools. At a number of these meetings I have addressed the members on agricultural teaching in elementary schools. My endeavour has been to indicate the best methods of teaching the subject, and, more particularly, to show a large number of simple experiments that can be performed without any more elaborate apparatus than glass bottles, tumblers and other readily obtainable articles with the idea of making school lessons more interesting and more intelligible. Not only have

the teachers evinced much interest, and shown by their questions an anxiety to profit by the lectures, but they have also carried out in their schools many of the suggestions with the result that, as several have stated at the meetings, the children are able to gain a correct idea of many terms and phenomena, which to the teachers themselves in their school days, were nothing but names with definitions that had to be committed to memory. It is obvious too from the newspaper reports of these association meetings that agricultural subjects come up very frequently for discussion. In many cases a member gives an account of the course of training in agriculture which he has attended, for the benefit of his fellow members who have not had the same opportunities.

It has been both gratifying and encouraging to observe the attempts at some of the schools to make the teaching more practical and more experimental. I will mention a few which may serve as types.

SCHOOL GARDENS.

Although very few teachers have so far applied for the special grant given by the Department for practical teaching, many have plots near the school where lessons are given from time to time. There seem to be three chief difficulties in the way of extending this work: (1) the lack of time, as on account of the irregularity of the attendance at the schools teachers find it hard enough to get through the regular work for the annual inspection; (2) the objections on the part of the parents, it seems to me that rather more is made of this difficulty than is necessary, for though it certainly does exist, the objections can be successfully removed, as they have been already in some cases, by the exercise of a little tact; and (3) the expense involved, much of this is initial and connected with such matters as fencing, and the purchase of the necessary tools.

Referring to grants to schools where practical agriculture has been taught during the year ended March 31 last, the Superintending-Inspector of Schools says in his Annual Report:—In some at least of the cases where these grants have been given the work has been of great value. In one of the most successful and satisfactory, Mount Fletcher in St. Andrew, I am informed that the school children beg for seeds and cuttings to take home and that not only are flowers eagerly sought after to be cultivated round the people's cottages but considerable quantities of vegetables, etc., are now raised locally and either consumed or sent to the Kingston market. The grant of £8. 7s. given in this instance is undoubtedly money well spent. The school garden is well worth a visit from any one who is interested in the development of agriculture amongst the people. The number of teachers who are competent to do work like this is, of course, limited; but leaving this consideration aside, an inspection of the accounts of the school in question shows clearly why these grants do not rapidly increase. Though, as I have said, it gets a Government grant of £8. 7s. and the sales of produce bring in over £5, these accounts show a deficit on the year's working, which must be

met by either teacher or manager. If, however, the amount of the grant were raised so as to show a clear profit to the school, and any large proportion of the elementary schools earned it, the aggregate cost would be very heavy, and would swell the total expenditure on education by thousands of pounds.'

It should also be remarked that this teacher has taken a number of prizes at agricultural shows, both in his own district and in Kingston; his chief rival being another teacher whose garden is also worth a visit, but which is not quite so favourably situated as Mount Fletcher, and on account of its position cannot be irrigated. Both these teachers attended the first course of training.

SCHOOL MUSEUMS.

In some schools the interest of the children is being stimulated by encouraging them to bring in botanical and agricultural specimens. A few weeks ago I saw a large collection neatly arranged, in a good-sized cupboard. The teacher showed me various kinds of seeds germinating, different types of soil, and simple experiments in course of being carried out. He stated that since he had started this museum the children had paid a much more intelligent attention to the science lessons, looking forward to them quite impatiently, and that his table was simply crowded with specimens if he asked the children to look for any.

BOX AND POT CULTURE.

Many of the teachers grow plants in pots and boxes for purposes of object lessons, though for the most part this work is confined to such as have received agricultural training. One school has a long row of tins in which simple soil and manurial experiments are being carried out; all having been arranged by the elder boys under the supervision of the teacher. By questioning the boys I found that they clearly understood what the experiments were designed to show and were eagerly noting signs of results.

A fair idea of what we may hope to see in all the schools in future when the training has been longer at work can be obtained from the Roman Catholic Schools in Kingston, where some of the Sisters who have attended the lectures at St. Joseph's College have introduced experiments and practical work with much success. It cannot however be expected that there will be any great improvement until this training has reached the whole of the teachers. Judging, however, from the signs that I have mentioned, it certainly seems as if the work of training the teachers in agriculture is having a good effect upon both the teaching in the elementary schools and the methods of agriculture amongst the peasantry.

The President: The papers just read by Mr. McFarlane and Mr. Buttenshaw, are a valuable contribution to the Educational side of the Conference. They clearly show the course of events at Jamaica in extending the teaching of agriculture

in the training colleges and elementary schools. It is evident that during the last three years efforts in that Colony have been well organised and that all concerned are joining most heartily and successfully in the work.

BRITISH GUIANA.

Professor J. B. HARRISON, C.M.G. (British Guiana): Much advance has not as yet been made in British Guiana in instructing the teachers, because, although a scheme was started eighteen months ago, the schoolmasters after attending twenty or thirty lectures suddenly went on strike. After the expiration of a few weeks another attempt was made, and we succeeded in getting about twenty or thirty schoolmasters to attend a course of lectures on elementary chemistry and botany given by one of the Assistants of the Government Laboratory. This was what I found had been done when I returned to the Colony in June last. At the request of the Governor a further course of fifteen or sixteen lectures was given on agricultural chemistry and agricultural matters in general. The teachers appear to have taken a great interest. Many, especially those living in the country districts, own some land which they try to utilize in teaching agriculture. It will however be some time before they can put into practice in their own schools the principles we have been trying to inculcate. In course of time we might hope to obtain good results.

We have, of course, difficulties to contend with. Our schools are spread over a large area and are often some sixty or seventy miles apart. This causes difficulty in getting the teachers together. Those within twenty or thirty miles of Georgetown, come in, receive their instruction and return home. We hope that these men will form in time the nucleus of a staff of teachers more interested in agricultural matters. It is proposed, as soon as an examination can be held, to give a course of demonstrations at the Botanical Gardens on practical matters in order to show the schoolmasters how to teach agriculture in their own schools. A sub-committee of the Board of Agriculture has been appointed to deal with this subject.

Mr. R. WARD (British Guiana): I travel in the country districts, and offer my assistance to the teachers. I have always found them very interested in their work. In addition I give practical instruction in field work, and similar matters.

[At this stage of the proceedings the President announced that the members of the Chemical Section would adjourn to a separate room to discuss certain questions that had been prepared, beforehand, and submitted for their consideration. The President nominated Professor Harrison as Chairman of the Section and Professor d'Albuquerque Secretary of the Section. See *ante* pp. 96-98.]

TRINIDAD AND TOBAGO.

Mr. R. GERVASE BUSHE (Inspector of Schools for Trinidad and Tobago): The first step taken with the view of including in the primary school course systematic instruction in the principles of agriculture was to endeavour to train the teachers already in charge of schools.

TRAINING THE TEACHERS.

A first course of lectures for teachers on Agricultural Chemistry and the Theory and Practice of Agriculture was held at Port-of-Spain in August, 1899.

The lectures on Agricultural Chemistry were given by Professor Carmody at the Government Laboratory and those on the Theory and Practice of Agriculture by Mr. Hart, Superintendent of the Royal Botanic Gardens, at the St. Clair Experiment Station.

The lectures occupied three weeks and at their conclusion an examination was held by each of the lecturers, both of whom expressed their satisfaction with the progress made by those who had attended the course. Twenty teachers were selected from among 101 applicants to attend the course: of these, eighteen actually attended and seventeen took the examination papers, and answered satisfactorily.

The second course for Trinidad teachers was held in January, 1900, under similar arrangements to the first course. The lectures were attended by eighteen head teachers and four students from the Government Training School. These were examined at the conclusion of the course, and were all reported to have paid great attention and to have made satisfactory progress.

In January, 1900, a series of lectures on the Practice of Agriculture was given to twenty teachers in Tobago by Mr. Millen, Curator of the Botanic Station. They all attended regularly, exhibiting the greatest interest and attention, and, on the conclusion of the lectures, answered a paper on the subject in a manner which was reported to bear favourable comparison with the papers of the Trinidad Teachers.

At the third course of lectures in Trinidad held in August, 1900, thirty-six head teachers attended, of whom thirty-two were examined at the end of the course, and were reported to have made good progress.

The fourth course was held in January, 1901, and was attended by twenty-six teachers and six students from the Government Training School. These all sent up answers to the examination papers which were set for them by the lecturers at the end of the course. They appear not to have done on the whole quite as well as those who had attended previous courses, but, with the exception of a few, their progress was reported to have been satisfactory.

In December, 1900, Mr. J. de Verteuil, Assistant Government Analyst, visited Tobago and delivered in Scarborough a course of lectures on agricultural chemistry to teachers employed in the Tobago schools. Twenty-four teachers attended, seventeen

of whom had previously attended Mr. Millen's lectures on the Practice of Agriculture in January, 1900. At the examination held at the end of this course twenty-two teachers sent up answers and the progress evinced by at least half of this number was reported to be satisfactory.

A fifth course of lectures was held in Trinidad in August, 1901, at which forty-eight teachers and seven students from the Government Training School attended, it having been the desire of his Excellency the Governor that as far as possible all those teachers who had not been to any of the previous courses should have the opportunity of now attending. This course was limited to two weeks instead of three weeks as in the previous courses. Professor Carmody has expressed the opinion that the two weeks course was not long enough and the results shown by the usual concluding examination were reported not to have been so satisfactory as on the previous occasions. Three or four of the teachers who attended this course had been present at the previous courses.

On the whole in Trinidad, the lectures have been attended by over 140 teachers from the elementary schools and seventeen students in training: whilst in Tobago seventeen teachers attended the lectures both on Agricultural Chemistry and the Practice of Agriculture. Some of these teachers should doubtless have an opportunity of attending another course; but of the majority Professor Carmody reports that they now possess the amount of knowledge required for the teaching of elementary agricultural science. As regards teachers to be certificated in the future, the annual examination for second and third class certificates now includes a paper on agriculture as a compulsory subject for male candidates.

AGRICULTURAL INSTRUCTION IN THE SCHOOLS.

With respect to instruction in agriculture in the schools, the Code which was amended at the end of 1899, provides that, from standard II upwards object lessons based on Blackie's *Tropical Readers* shall be given to all scholars, the ground covered by these Readers being gone over in standards II to V; whilst in standard III and those above, the Code directs that the practical agriculture shall take the form of practical illustration and application of the lessons from the *Tropical Readers* in school plots or pots and boxes.

In the middle of the present year a pamphlet by Mr. Collens, who was acting as Inspector of Schools, containing *Hints on Object Lessons and the Teaching of Agriculture in Primary Schools,* was issued for the guidance of teachers.

As an inducement to teachers to give their attention to practical agriculture, an annual bonus is payable to each head teacher on the results of the annual examination of his school, in addition to the teachers' salaries, which, in all the primary schools, are paid by the Government.

GRANTS FOR PRACTICAL WORK.

The maximum bonus paid at present is four shillings for

every scholar in average daily attendance during the year, and of this sum one sixth is allotted for proficiency in the object lessons referred to above, and another sixth for proficiency in practical agriculture, one-third of the maximum bonus being thus allotted for proficiency in agriculture in the results of the annual examination. The allotment of a portion of this bonus in favour of practical agriculture dates from the beginning of 1901, and, during the year, forty-eight of the 200 schools examined in Trinidad showed results of work in school plots described either as 'fair,' 'good,' or 'very good,' the head teachers obtaining a proportionate share of the bonus accordingly.

From reports recently received it appears that of schools visited by Inspectors in October, November and December, fifteen have started work in school plots since they were last examined, and from returns furnished by teachers that about twenty more have started school plots since the date of the Inspectors' last visit. Of the twenty-six schools in Tobago, three had started work in school plots when they were examined, and four others appear to have done so since they were examined.

On the whole in Trinidad and Tobago together about ninety schools have commenced working school plots, as far as I have been able to ascertain.

As an encouragement to the schools that have commenced this practical work an exhibition of the vegetables grown in the school gardens is to be held in Port-of-Spain in a few days, and forty-one schools intend to send up exhibits; four or five others having been prevented from doing so by circumstances beyond their control, the chief being the loss of produce by theft at nights. The prevalence of praedial larceny will, I am afraid, in many districts prove a serious discouragement to school gardens, for which even fences may not provide a satisfactory remedy. In some cases a difficulty in the establishment of school plots arises from the reluctance of managers to provide the necessary tools. On the other hand the objection on the part of parents has not presented the difficulty that was anticipated.

The PRESIDENT: We are fortunate to have had the pleasure of receiving from Mr. Bushe, himself, an account of efforts to extend the teaching of agriculture in the elementary schools at Trinidad. The Governor, Sir Alfred Moloney, has so warmly supported these efforts that they cannot fail to be successful. A striking feature at Trinidad is the very large number of school plots that have, already, been started there and at Tobago. I understand that about ninety schools are now engaged in working school plots. These are no doubt encouraged by the special prizes to be offered at an exhibition of vegetables and produce from school plots. The latter plan has been successfully introduced, also, at Barbados.

BARBADOS.

Rev. J. E. Reece (Inspector of Schools, Barbados): A third course of lectures was delivered last year by Mr. R. Radcliffe Hall (Assistant to the Island Professor of Chemistry) and Mr. J. R. Bovell (Superintendent of the Botanic Station) to some twenty elementary school teachers. At the examination held after the lectures ten teachers were placed in the 'first rank.'

RESULTS OF LECTURES TO SCHOOL TEACHERS.

As the results of the courses of lectures delivered during the last three years we have now thirty-four teachers who are deemed competent to impart instruction to their pupils in the principles of agricultural science. There are altogether fifty-two schools in which big boys are taught. Some of these schools are under the charge of men who have been in the service for twenty-five or thirty years, or more, and are reluctant to submit themselves to the test of an examination along with younger men, and therefore have not offered to attend these lectures. A few have attended them, but have failed to obtain a sufficient number of marks to entitle them to be placed in the 'first rank'; so we may say that for the present, all the teachers of boys schools who were willing to attend the lectures, and able to pass the examination, are possessed of the qualification required for teaching this subject.

During the past year the boys in twenty schools were prepared for examination in portions of Books I and II of Blackie's *Tropical Readers*. At the annual premium examination of their schools 463 boys were offered for examination, and 187 passed. Some of the teachers whose schools were examined in the early part of the year were not quite prepared, or the result might have been better; but still forty per cent. is not a bad result; it is a better result than we get in grammar, and much better than we get in history and geography. In this year more schools will be eligible to present boys for examination in this subject and the proportion of passes ought to be greater also.

PRACTICAL WORK NECESSARY.

This is good so far as it goes; but we do not consider it sufficient for our requirements. We want something more for our children, most of whom must some day earn their living by agriculture. We want practical work. And this has not been lost sight of by the Commissioner of Agriculture, who has furnished an incentive by offering prizes, at a local exhibition to be held during this month, for plants grown in pots or boxes by children in elementary schools. We must not be disheartened if the number of competitors on this occasion, the first of its kind, be small. The teachers were apprised of it only a few months ago, and the seeds kindly supplied by the Department in many cases failed to grow. Perhaps, too, if, as in the case of our agricultural exhibition in Bridgetown, prizes had been offered for the *produce* of the plant, instead of for the growing-plant itself, there would have been more competition.

I am quite of opinion that the plan adopted is the better, but just at first the other plan might have shown better results and have excited more interest. Attempts of this kind take repeated effort, but will grow and gain popularity as time goes on.

SCHOOL GARDENS.

I have very little progress to report in the matter of school gardens. Two teachers during the year have had the little plots around the school-house cultivated by their boys, but in the majority of cases there is no land available for school gardens. In Sweden each parish provides a plot of ground for a school garden. I do not know if the day will ever come when the Vestries of the several parishes in Barbados will do the like. At present there seems little prospect of its accomplishment: but is it not the only way to make our teaching practical, and to put an end to the complaint that it is 'too bookish?' The excellent hand-book *Nature Teaching* compiled by Mr. F. Watts, and the admirable pamphlet drawn up by Mr. W. G. Freeman, both generously supplied to our teachers by the Imperial Department of Agriculture, will be found most useful, and our best thanks must be given to those to whom we are indebted for them. Our difficulties are certainly great, but they are not insurmountable: only let us show that we are in earnest in teaching our peasantry to use their hands intelligently and usefully in the work on which rich and poor alike have to depend for their maintenance: and let us hope that quiet perseverance in a good cause will eventually issue in success.

His Lordship the BISHOP of BARBADOS: I do not know that I have anything to state in particular about Barbados, except to endorse what Mr. Reece has so well stated. As you have heard we have had lectures to teachers and have now thirty-four who are deemed capable of teaching agriculture in elementary schools and of giving object lessons, illustrated by the black-board as suggested by the President just now. I do not know, however, what part the illustrations on the black-board are intended to take. It strikes me here in Barbados it will be very small because in the education of this island drawing has been until lately entirely neglected, and I doubt whether many of the teachers are able on the black-board to draw a straight line. It seems to me that this is a grave neglect and one which will interfere greatly with the teaching of agriculture. It is a defect which ought to be speedily remedied, because drawing is not only a necessity for agricultural teaching, but it lies at the bottom of every handicraft. There is another want in this Colony—the want of a suitable Training College for our schoolmasters. There are many difficulties in the way of this I am aware: for instance, the small number of students and the expense. We have very little money in Barbados to spare for this purpose. His Excellency is here, and he may perhaps sooner or later tell us how this want may be met. On the whole, I think we may congratulate ourselves in Barbados,—which differs in many ways from the other islands—upon having done the best we could with the means we have had at our disposal. We are teaching our children to observe, and giving definite instruction

in agriculture to the higher standards. I hope we shall be able before long to offer grants for practical work in agriculture.

His Excellency Sir F. M. HODGSON, K.C.M.G. (Governor of Barbados): I should like to make a few remarks upon the establishment of a Training Institution for teachers. In Barbados this important matter has not been overlooked. It was suggested by this Government that there should be a training institution common to Trinidad, British Guiana, Barbados and such other Colonies as would join in this mutual arrangement, but the scheme did not meet with general approval. If those delegates here to-day who are interested in education will urge their respective Governments to take up the question, on some co-operative plan, Barbados, I venture to say, will be ready to join. By itself it cannot act because the cost of establishment and the cost of maintenance of a Training College are more than the Colony can bear at present.

GRENADA.

Mr. J. HARBIN (Inspector of Schools, Grenada): The law of the Colony under which Primary Education is administered exclusively by a Board of Education) dates as recently as 1896, and came into full force in every school on March 31, 1897. Under this law and the Code promulgated under it, provision has been made for the teaching of agriculture in the highest standards (vi and vii) to boys only. Such instruction is purely theoretical.

LECTURES TO TEACHERS.

The views of the Imperial Department of Agriculture have been duly conveyed to the Government of the Colony, and, at courses of lectures delivered in January and August 1900, by lecturers appointed by the Department, to all the male elementary school teachers and a few assistant and advanced pupil teachers numbering in all about fifty each course of lectures lasting for about ten days under the Presidency of his Excellency Sir Alfred Moloney, K.C.M.G., Governor, and President of the Board of Education, full publicity was given to the views of the Colonial Office, the Imperial Department of Agriculture, and the local Government. These lectures were followed by examinations, the results of which the lecturers on each occasion expressed themselves as being thoroughly satisfied with. After the examination at the August course, some practical work was engaged in by teachers selected by the Government, to classes got ready beforehand for the purpose of showing how far the work of the lecturer had been successful, and was very much appreciated by the President and a full and representative audience.

The well known difficulties of enlisting the best services and sympathies of the teachers in the matter of manual labour in connexion with the soil have to be reckoned with in Grenada as in other places, and the unfortunate fact remains that on the occasion of the first course of lectures, a teacher of an assisted

school under the management of the Vicar General of the Colony, actually contributed a letter *above his signature* to one of the newspapers of the Colony, suggesting, on account of the amount of monetary *assistance* offered by the Imperial Department of Agriculture to the teachers towards their expenses, ideas which, had they been taken up by the body of teachers, would have rendered abortive on that occasion the efforts of the Imperial Department and the Government. The second course of lectures seven months afterwards met with an entirely different condition of affairs, and I believe that, to-day, all the teachers, including the writer of the letter before mentioned, are grateful to the Imperial Department of Agriculture for assistance, and think better of themselves if only for the educational value of the two courses of lectures and demonstrations they have received.

Result grants at the rate of 3*s*. for each pass in agriculture (Dr. Tanner's and Dr. Nicholls' works being the text-books approved by the Board of Education under the 1896 Code) have been paid since 1897 at the annual examinations, but as already noted this has been for purely theoretical instruction.

Facilities have been offered by the Curator of the Botanic Station, which lies at the southern end of the town, for allowing the boys of the three town schools to receive weekly instruction in gardening, the preparation of soil, the use of tools, etc., and to my certain knowledge, two of these schools have availed themselves of their opportunities, and further arrangements have been made for a regular continuation of this course of study by all of them from January 1902. Since the delivery of the two courses of lectures, the teachers have been teaching from the notes taken at the lectures and corrected by the lecturer, and, as a consequence, the instruction imparted has been much more definite and to the point, the difficulty of teaching from text-books what they did not very well understand being thus obviated. One decided advantage of teaching from these notes is that the teachers eventually learn *thoroughly* all that has been committed by them to paper. The results of the examinations are distinctly satisfactory so far, and about three boys, on an average, between the ages of fourteen and eighteen, leave each school annually with a fair elementary knowledge of plants and plant life capable of being turned to good account in a small garden.

SUGGESTIONS FOR THE FUTURE.

While these results may be considered sufficiently good to be called a start, yet I see room for the adoption of one or both of the following courses:—

(*a*) The examination in agriculture by the Inspector of Schools should be on a different day from that for the annual inspection, owing to want of sufficient time for a thorough examination on the practical side of the subject.

(*b*) The Curator or the Agricultural Instructor in the Colony should assist the Inspector (at least in the practical work in school gardens), a substantial result

probably being that the Agricultural Instructor, if thus engaged, would come directly in touch with children, whom sooner or later he will find himself instructing as peasant proprietors, and would thereby come to 'know his men' better, and generally find his particular duties as Agricultural Instructor less onerous and more pleasant.

Among the special difficulties to be overcome in Grenada in future are: —

(*a*) The lack of stimulus for giving the necessary prominence in the curriculum to the teaching of agriculture.

(*b*) The securing of school plots.

(*c*) The protection from praedial larceny (where schools are in populous districts and without caretakers) of such plants as may be growing in pots and boxes for purposes of instruction and demonstration.

As regards (*a*) the general feeling is that unless the teachers are specially paid or receive higher result grants for this wider and more difficult subject than the 3s. now paid for the 'three R's' and the extra subjects, the time desired for this subject will not be devoted to it. This particular aspect of the question is now engaging the attention of a committee, already in session, and, with the aid of the Government, a solution of the difficulty may soon be expected.

THE SECURING OF SCHOOL PLOTS.

Full inquiry into this matter has been made by Sir Alfred Moloney with a view to an early settlement, and the matter might now have assumed a definite shape but for the fact that no fewer than four school managers, with fifteen schools under them, will be leaving the Colony within a very short period, leaving the schools to entirely different management. Negotiations will doubtless be opened with the new managers without delay.

THE PROTECTION OF PLANTS, ETC.

This is a difficulty which has shown itself in one or two schools where the teachers have been enterprising enough to supply their lack of plots by working in boxes, etc., on a small scale. The use of boxes and tubs is certainly one sure method of gradually removing the distaste or objection that is so largely prevalent against handling the soil. The difficulty of protecting the plants from being stolen may seem trifling, but it is by no means imaginary.

The PRESIDENT: Grenada is well known to be in a prosperous condition, but from the educational point of view it would appear to be not so satisfactory as could be wished. This directly affects the question of agricultural teaching and training of the rising generation. The average attendance is only fifty-two per cent. of the names on the school books, although it is stated there is a school within two miles of every peasant family in the island. In the sugar islands the average

attendance follows closely the price of sugar. It is highest when prices are good and wages plentiful, and lowest when wages are scarce. At Grenada where the peasants are all comparatively well off, it is discouraging to find that the school attendance does not show to better advantage. Mr. Harbin takes a deep interest in his work and it is hoped with his assistance the educational authorities in the island will be successful in improving the educational position, and ensure that the peasant proprietors of the future will receive a sound agricultural education.

I regret to state that we have no reports from St. Vincent and St. Lucia. The Inspector of Schools for St. Lucia (Mr. F. E. Bundy) is unfortunately absent owing to quarantine regulations and there is no one representing the educational interests of St. Vincent.

I suggest we now proceed to deal with the Leeward Islands. Mr. C. M. Martin, the Inspector of Schools in that Colony, has under his care about 26,000 children. He has been good enough to prepare a summary of the efforts to introduce the teaching of agriculture into the schools of the Leeward Islands and I have pleasure in calling upon him to address the Conference.

LEEWARD ISLANDS.

Mr. C. M. MARTIN (Inspector of Schools for the Leeward Islands): The regulations at present in force in the Leeward Islands with regard to elementary schools do not require that agricultural instruction be given. Object lessons on local plants are given in standards VI and VII, but these have not been altogether satisfactory. The difficulty we have had to face was that of the teacher. The unwisdom of requiring teachers to teach a subject with which they have little or no acquaintance is obvious.

LECTURES TO TEACHERS.

The majority of the teachers have now attended two courses of lectures given under the auspices of the Imperial Department of Agriculture and have received practical instruction in the various Botanic Stations. While the present regulations do not require agricultural instruction to be given, it must not be thought that the subject has been entirely neglected in the schools. Most of the teachers have given a course of lessons based on the lectures they have heard, and at nearly every inspection I have held during the past year I have listened to a lesson on the subject given by the teacher. In a few schools, practical work in the preparation of seed-boxes and in the sowing of seeds has been presented, and the lessons referred to in my last sentence have, almost invariably been illustrated by specimens. In many of the schools, specimens have been provided for all the children, who have, on the whole, shown an intelligent knowledge of the different parts of a plant. A ground-work has thus been laid for a new scheme of work which will be in force during the present year.

SIMPLICITY IN TEACHING NECESSARY.

Enough has been seen in the attitude of both teachers and children towards the new subject to allow the hope that the instruction, if guided along right lines, will be of the utmost value to the schools. Difficulties are inevitable in the proper introduction of a new subject such as this, especially in West Indian schools. The tendency of our teachers is, as is well known, to envelop any subject they teach in a cloud of high-sounding terms. Simplicity in the teaching must be aimed at. The real object of the instruction, which I prefer to call 'nature-teaching,' rather than agriculture, is to arouse in the minds of the children an intelligent interest in the objects that surround them in the country, especially such objects as are nearly connected with agriculture. The idea that technical instruction, properly so called, can be given in an elementary school, has, I take it, been abandoned; but practical instruction, which is something less than technical, can be given. The intelligent interest I have referred to can be best promoted by a simple course of lessons told in simple language. The introduction of matter, such as the chemistry of the plant and soil, except when explainable in simple, easily-understood words, and technical terms and definitions, except when absolutely unavoidable, is to be deprecated. There is already too much learning by rote in our schools and too little exercise of the intelligence. Thus any scheme which will give opportunity to a teacher to cram into his pupils long lists of technical words and definitions will but defeat the object we have in view. Such a scheme will only add another subject to the school course without corresponding benefit to the unfortunate children. A definite and not ambitious scheme of instruction is what is required. It is essential to the success of such a scheme that the instruction should be practical: that is, illustrated in every case with specimens of the subject of instruction. It is important to grasp clearly that unless this subject is taught, on the lines indicated above, the teaching will be merely a matter of words, and of little or no educational value.

SUGGESTIONS FOR THE FUTURE.

What it is proposed to adopt in the Leeward Islands is as follows:—The elementary school will be arranged in three divisions, the lower consisting of standards I and II, the middle of standards III and IV, the upper of standards V, VI and VII. In the lower division descriptive lessons on domestic and wild animals compared with each other will be given, and simple conversational lessons on a few useful plants such as the sugar-cane, coffee, cacao, etc. In the middle division, the sugar estate, lime, cacao or coffee plantation, its buildings and their contents; the animals kept on these places and their uses, the need of cleanliness, kindness and suitable food for these will be treated of. Then plants as growing things, so as to lead on from the simple lessons of the lower division to the lessons of the upper, which will be based on Mr. Watts' book, *Nature Teaching*. In this middle division, the

teacher will speak with the children of the plants which grow on the riverside, in running or in still water; meadow or field plants; plants of the hills, woods and sea-coast; plants which help or are harmful to man: ferns, mosses, and lichens; plants as herbs, shrubs and trees. Then the various parts of a plant, flowers of different shapes, seeds, fruits and leaves of different shapes. In every case the children will be encouraged to collect and to bring to school specimens to illustrate the lessons, and the *Tropical Readers* will be largely used in the two lower divisions.

In the upper division the plant will be considered as a living thing. Thus the structure of the root, stem, leaf, flower and fruit of the plant will be studied and the functions of these parts explained. To this will be added an outline of the nature of the soil and the functions of soil, air and water in supplying food to the plant, as well as some knowledge of manures. *Nature Teaching* will be used as the text-book for this division, but it will not be placed in the hands of the children, as it is essentially a teacher's book.

It is proposed that at first only a selected number of teachers will take up this instruction in the schools, and in no case will the subject be sanctioned unless an adequate supply of materials for illustration is obtained. More good will, I think, result in the end by going slowly at first. When it is seen what the subject is capable of in the hands of the best of the teachers it will be possible to extend the scope of the scheme.

SCHOOL PLOTS.

The importance of introducing careful and correct methods of cultivation, especially in the smaller and poorer of the West Indian islands, will not be denied. One cannot but be struck, amidst much poverty and distress, with the neglect of opportunity exhibited in the small plots of land around the peasants' cottages. The almost entire absence of *petite culture* is a striking feature of the social characteristics of the people, and it may reasonably be hoped that the establishment of school gardens will do much to promote and ameliorate the condition of the population. The spread and promotion of simple, but scientifically correct, cultural operations is the object aimed at in the school plot, and the love of agriculture for itself may follow as another beneficial result.

At present the school plot may be considered as being in the experiment stage in the Leeward Islands; but a description of what we have attempted, and a statement of the results we have so far obtained, may be of value in pointing out the course we may have to pursue in the future. The typical school plot consists of six beds, varying in length from forty to fifty feet, five feet in width and separated by paths two feet wide. As it is the object to instruct the children in cultural operations and not to exact heavy manual labour from them, the beds are roughly prepared by hired labour. It is worthy of notice that serious objection was taken in one island to the establishment of a school garden on the ground that heavy labour was to be

demanded of the children: it is therefore important to avoid arousing any antagonism on this or on other grounds.

The beds are worked up by the boys into a condition fit to receive the seeds or seedlings. As a matter of convenience, we have found it best to cultivate some of the more common English vegetables such as lettuce, turnips, carrots, kohl-rabi, cabbages, tomatos, etc. A certain number of boxes for raising seedlings are provided, and these boxes are prepared for the purpose by the children themselves. Thus, the instruction given in the school plot may be summed up under the heads of (1) preparation of boxes and beds, (2) sowing of seeds, (3) transplanting, and the various processes necessary for the care of the plants during progress to maturity. In each plot a compost heap is formed so that the boys may realize the importance of utilizing what is too frequently burnt or disposed of wastefully. This course of work it was thought well to adopt at first, until further experience should show in what way and in what directions it might wisely be extended. A too ambitious programme would possibly have failed. For similar considerations, the class is limited to twelve boys chosen from the four upper standards of the school, a sufficient number for one teacher to control efficiently and to instruct properly. Each bed is in charge of two boys, and in each bed an equal space is planted with the different kinds of vegetables: it is thus possible to compare the work for which each pair of boys is responsible.

The class meets for two hours in the week in the afternoon; but in cases where the plot is not situated within a Botanic Station, watering of the plants has to be done by the children at times outside the regular hours of work.

Each teacher keeps a school plot diary. In this diary he records for each day the work done and any remarks he thinks may be necessary for the information of the Inspector. In addition, there is a record of marks for each boy for each day he works on the plot. This is useful when, as in most cases, small prizes are offered for good work.

The produce of the beds is distributed among the boys who can either sell or dispose of it as they please, thus removing an objection sometimes raised by parents against their children doing this practical work. In certain convenient places, it is proposed to add to the school plot a bed to be worked by all the boys and planted with some marketable produce which will provide a fund for prizes and the purchase of materials. Up to the present, the Imperial Department of Agriculture has provided seeds and tools, and without its aid the scheme could hardly have been initiated. In the near future, however, local funds will be available, I hope, to carry on and extend this educational work.

TOOLS FOR SCHOOL PLOTS.

With regard to tools, it should be observed that in order to avoid confusion and resulting waste of time these should be sufficient in number. It has been our experience that the want of a sufficient number of tools leads to enforced idleness on the

part of the boys and prevents systematic work. Where sufficient money is available, the most convenient selection of tools would consist of a spade, fork, trowel, and hoe for each boy, a rake for each bed, two watering cans, a line, and a sieve of half-inch mesh. The cost of this set of tools would probably amount to £6. It is possible to get a set of tools, not as complete as the former, for about £3. 10. but when funds are not available to procure sufficient tools as given in the above list, it would be better, in order to avoid the evils I have pointed out, to reduce the size of the class rather than the number of tools available for each boy. In this way, two classes may work in the week and thus, in the end, an equal number of boys would receive instruction.

With regard to the care of the tools, we consider it a valuable training to insist that the boys should clean these after work and see them properly put away in the shed or storeroom. As yet we have not attempted anything in the direction of manurial experiments, but next year more advanced pupils will be instructed in grafting and budding, and, in the Botanic Stations where hives are kept, it is hoped that demonstrations in bee-keeping can be arranged for.

The results obtained during the past year in the school gardens, if not brilliant, are at least encouraging. Most gratifying is the spirit shown by the boys who evince great interest in the work. The subject has been new to the teachers and further experience will give them greater facility in handling their classes. On the whole, *their* interest is not less than that of their pupils, and we can look forward in the present year to a satisfactory advance in the development of the scheme.

The President: In his interesting paper Mr. Martin has stated that the scheme of general education in the Leeward Islands is compulsory. I should like to ask him whether the teaching of elementary science is also compulsory, as in Jamaica?

Mr. Martin: It is.

Mr. F. H. Watkins (Commissioner of Montserrat): We are grateful to the Imperial Department for its practical efforts to introduce the teaching of agricultural science in the schools of the Leeward Islands. As the President is aware, ever since I took up educational work in the Leeward Islands I have endeavoured to have agricultural training introduced into all the schools, but from one cause and another, the matter did not take definite shape until after the advent of the Imperial Department of Agriculture. The older teachers objected to agricultural teaching, being of opinion that it should be taken up by the younger teachers, and personally, I am of opinion that we shall have to look generally to the younger teachers for the further development of the scheme. Some of the younger teachers objected because of soiling their hands, but when they found that teaching the subject would bring them perhaps increased incomes in the future, that objection was soon dropped, and during the last year they have shown the greatest interest in the work. Recently we had the pleasure of hearing in Montserrat Mr. G. Whitfield Smith's clear and interesting

lectures, which were appreciated not only by the teachers but by the public generally. The Acting Bee-expert to the Department, also gave lectures to the teachers, and I am glad to say that they have taken up the work in several schools. Two school plots have already been prepared in the country, and an area in the town belonging to the Government is now being cleared and will I hope very soon be enclosed for use as a school plot. It is pleasant to see the advance which has taken place during the last two or three years in elementary education in the West Indies.

Dr. N. G. COOKMAN (Commissioner of the Virgin Islands): Agricultural education in the Virgin Islands is, owing to its having been but recently instituted as a branch of school teaching, in a somewhat elementary stage. The efforts, too, made to promote it have been hampered by that distrust in innovations emanating from a Government source, which seems to be inherent in small native communities.

Two courses of lectures have been delivered in the Virgin Islands by Mr. G. Whitfield Smith to teachers during the past two years, and he has in connexion with these lectures been indefatigable in his efforts to explain the objects of the new form of instruction as well as to arouse a healthy spirit of interest in teachers, parents and children.

The publications of the Imperial Department of Agriculture have been issued to teachers and the principal residents. Beds have been prepared at the Agricultural Station by the Instructor with a view of affording practical object lessons and instruction to the scholars from the schools near the Station. It has been arranged that the produce from these school plots be sold for the benefit of the children who cultivate them. These measures, together with box and pot cultivations, to be established at the schools themselves, constitute what has been done towards introducing agricultural education in the Virgin Islands.

I am, however, grateful to say that no suggestion for the benefit of the scholars in an agricultural direction has escaped the interest and consideration of the Imperial Department, and it is certain that when the parents fully realize what is being done for their children, benefit of a permanent character must accrue to the Presidency.

Mr. A. J. JORDAN (Montserrat): A little over a year ago a course of lectures was delivered to the teachers by Mr. G. Whitfield Smith, and the teachers have also received instruction with regard to cuttings, sowing seeds, etc. In June of last year an attempt was made to start two garden plots, one at Olveston and the other at Harris' Village. One of these plots is sufficiently large to allow manurial experiments to be conducted on it. At one of the schools, by request of the Managers, I assisted the master in showing the children how to lay out and cultivate the garden. This garden is now doing well. At the other school I tried to help the master, but without success. No difficulty has been experienced with the parents in regard to agricultural instruction; far from that they are most anxious to have school plots established.

The PRESIDENT: We have now completed our review of efforts during the last three years to introduce the teaching of agriculture into colleges and schools of the West Indies. I believe you will agree with me that we should be satisfied that a general and, on the whole, successful attempt has been made in this direction and that the prospects for the future are distinctly encouraging. There are one or two points that have cropped up during the discussion that deserve notice. Reference has been made by the Representatives from Grenada and Trinidad to the difficulties, in connexion with establishing school plots, likely to arise from the liability of plants and produce to be stolen. This opens up the thorny subject of praedial larceny which can only be dealt with according to the conditions existing in each Colony.

His Lordship the Bishop has referred to drawings on the black-board as an essential qualification for teachers. There can be no difference of opinion on this point and it is hoped that every opportunity will be offered to the present teachers to qualify themselves, otherwise object lessons and the general teaching in the schools cannot be satisfactorily carried on.

Mr. Harbin has thrown out a suggestion that the travelling Agricultural Instructors connected with the Imperial Department of Agriculture might very usefully assist the inspectors and teachers in raising plants in pots and boxes, and in starting school gardens. If the services of these officers are asked for by the educational authorities in the different Colonies I believe there would be no difficulty in arranging that the Agricultural Instructors should assist in the direction mentioned. It must, however, be understood, that the first step must be taken by the Education Boards and that they should formally invite the co operation of the Department. In addition I find at Jamaica the Agricultural Lecturer (Mr. Buttenshaw) attends meetings of Teachers' Associations in the country districts and gives short addresses on agricultural subjects. I believe by these means the interest of the teachers is aroused and they are encouraged to introduce the teaching of agriculture into their schools.

I would touch on one more matter, and that is in connexion with the Lectures to teachers in charge of schools in the Windward and Leeward Islands and Barbados that have been carried on during the last three years by the special Lecturers employed by the Imperial Department of Agriculture. The expenses of the Lecturer and also the cost of travelling and maintenance of the teachers while attending these lectures have been borne by the Department. This assistance was understood from the first to be of a temporary character, and it will cease as soon as the present teachers in charge of schools have all qualified. There will still remain the question of keeping up the interest of the teachers in their work and also the training of the young teachers who will shortly have charge of schools.

Before closing the discussion I would invite an expression of opinion from the Conference on some of the points above referred to.

GENERAL DISCUSSION.

Mr. A. B. McFarlane (Jamaica): At the Mico Training College drawing is made a primary subject and special attention is given to black-board drawing. The teachers evince great interest, and in their object lessons are required to use the black-board freely. I would suggest that:—

(1) Drawing be made a primary subject in all elementary schools. (2) Regular instruction be given for at least one and a half hours per week throughout the school year. (3) Teachers should have abundant practice in black-board drawing. (4) All object lessons should be illustrated with numerous black-board illustrations. Many of these illustrations may be prepared beforehand. (5) Teachers should be required to draw *from memory* objects familiar to school children.

The Hon'ble S. Olivier (Jamaica): We need in Jamaica, and probably the want is felt in other West Indian Colonies also, an elementary text-book for the guidance of teachers in giving object lessons and demonstrations on the black-board. I have in my mind a book, somewhat on the lines of *Nature Teaching*, issued by the Imperial Department of Agriculture.

Mr. J. A. Harbin (Grenada): With regard to the importance of having more attention paid to the subject of drawing, a point raised by his Lordship the Bishop, I would like to add a few remarks. The emoluments of elementary school teachers in the West Indies and British Guiana are made up from two main sources: (1) A fixed emolument attached to a certificate of efficiency gained by passing an examination in a curriculum of general subjects these certificates being graded 1st, 2nd, and 3rd class respectively; and (2) A result grant, depending on the results of the annual examinations. I am of opinion that if the subject of drawing were included in the curriculum of general subjects, and made compulsory in the earning of certificates, the remedy for this weak spot in our educational system would at once be found, as not only the teachers but the pupil teachers would take up the subject, and gradually remove the defect complained of.

The Hon'ble G. T. Fenwick (Trinidad): I feel sure that all interested in agriculture in the West Indies will appreciate the reference made to that curse of these Colonies, praedial larceny.

I am of opinion that in the work to be proceeded with for encouraging agricultural science among the West Indian peasantry, the best means of suppressing this crime should take first rank. It is useless to expect men of small means to put what little they possess into cultivating land without some guarantee or security that they will be allowed to reap the reward of their industry and hardly acquired knowledge.

Flogging is the only real deterrent. In Trinidad a law was passed some years ago giving the magistrates power to order flogging in certain cases, subject to the approval of the Governor. The Governor approved several such sentences with the result that the crime was almost entirely stamped out. Another Governor came, animated by extremely

humane sentiments, who refused to approve all sentences of flogging, and with this encouragement the crime revived and became more prevalent than ever. It can hardly be more so than it is now. The present Governor is understood to be determined to let the law take its course, but several years' experience of having their sentences quashed has so discouraged the magistrates that they now refuse to convict.

Sir FREDERIC HODGSON: I sincerely hope that the Imperial Department of Agriculture will not attempt to deal with the important subject of praedial larceny. I think it is outside the scope of the Department. Praedial larceny is a crime which the Governments of the various Colonies should take in hand, and in dealing with the question should endeavour to go to its root. It is all very well to provide drastic punishment, but that will not stop praedial larceny. Praedial larceny, in my opinion, arises in many cases from the poverty of the people, and until we can improve their condition we shall never be able to wholly stop this crime. Mr. Fenwick alluded to the punishment of flogging and said it was the only real deterrent. I am very much opposed to flogging for offences of this character. We have a much worse form of crime in Barbados, the firing of cane fields, but flogging is not imposed. If we can better the general condition of the people praedial larceny will probably cease of its own accord.

THE PRESIDENT: Praedial larceny, I admit, is an important question affecting the prosperity of these Colonies; but in any case as no notice has been given of the intention to bring it forward to-day, we are not in a position to deal fully with it. Further, I understand it is now under the consideration of the Secretary-of-State.

I take advantage of the conclusion of the papers and discussion on educational subjects to propose that the members of the Educational Section should adjourn to a separate room to discuss the several points to be submitted to them. His Lordship the Bishop will be Chairman and Mr. C. M. Martin (Inspector of Schools for the Leeward Islands) Secretary of the Section.

Dr. H. A. A. NICHOLLS (Dominica): I should like to say a few words before the Educational Section retires. In some of the West Indian Colonies, more especially in Dominica, St. Lucia and Grenada, the lower orders of the people speak a French patois. A quarter of a century ago this patois was the general language of the labouring population; but, owing to the successful efforts made by the Governments in the spread of primary education there is, year by year, less patois spoken in the Colonies named. During the discussions at this Conference on educational matters, the question of the difficulty produced by the prevalence of patois has cropped up, and I believe it has been suggested that it would be, perhaps, advisable to publish leaflets or pamphlets in patois in order to endeavour to reach those who neither speak nor understand English. I hope, Sir, that this is simply a suggestion, and that it has not taken definite shape. For, it appears

to me that anything calculated to prevent the dying out of this patois will be a retrograde step. The almost universal use of the patois in Dominica in the past was undoubtedly a positive curse to the country and to the people. It prevented the spread of knowledge and civilization. Accordingly, whilst the neighbouring English speaking Colonies progressed, Dominica remained in a backward condition. Some years ago the late Bishop Branch of Antigua, with the idea of reaching those people of Dominica who understood nothing of English, had one of the Gospels translated into patois. As soon as this became known a strong representation was made to the Bishop, pointing out to him the evils that would be created by any circumstance tending to perpetuate the patois. Bishop Branch fortunately allowed himself to be influenced by these views, and the publication in patois—brought out with considerable expenditure of time and money—was never circulated in Dominica. I hope that no attempt will be made by the Imperial Department of Agriculture to translate any publication into this French patois, for it is inadvisable to do anything that would tend to prevent the final disappearance of such a hindrance to progress as this patois has proved itself to be.

REPORT OF THE EDUCATIONAL SECTION AT THE CONFERENCE, 1902.

The Educational Section was founded in 1902 to allow of the thorough discussion of educational matters by the members particularly interested.

At the meeting of the Section held on Monday, January 6, 1902, the members of the Conference present were:

The Right Revd. the Lord Bishop of Barbados, Chairman.
C. M. Martin, Esq., (Montserrat) Secretary.
Revd. Canon Simms, (Jamaica.)
A. B. McFarlane, Esq., ,,
W. R. Buttenshaw, Esq., ,,
G. F. Franks, Esq., (British Guiana.)
R. G. Bushe, Esq., (Trinidad.)
Revd. W. Carroll, Esq., ,,
J. A. Harbin, Esq., (Grenada.)
H. Deighton, Esq., (Barbados.)
Prof. J. P. d'Albuquerque ,,
Dr. Longfield Smith ,,
Revd. J. E. Reece ,,
A. Howard, Esq. ,,

The following suggestions were submitted to the consideration of the Section by the President:—

(A) It is desirable in the first instance to define what is meant by 'Agricultural teaching' in elementary schools.

The following is suggested. (*a*) In the lowest classes a definite number of simple object lessons to be illustrated by pictures, drawings on black-boards, or the objects themselves, dealing with the facts of every day life, for example, plants, animals, air, water, soil, etc. (*b*) In the middle classes a definite number of object lessons requiring a slightly higher standard of knowledge with an intelligent acquaintance with some chapters in Blackie's *Tropical Reader*, Book I. (*c*) In the upper classes Blackie's *Tropical Reader*, Book II, with a wider knowledge of plants and animals and other natural phenomena, and some acquaintance with the growth and treatment of plants and their uses.

Where pot and box culture is possible and where a school garden is attached, the knowledge required should be of a wider character and a larger grant offered.

(B) An expression of opinion is desired as regards the character and number of pictures and diagrams for use in Elementary Schools. Some of these are exhibited in the Conference Hall.

(C) How far is it possible or desirable that teachers should receive further assistance in qualifying themselves to teach agriculture in elementary schools? Could teachers meet at certain centres and receive instruction from Lecturers in Agriculture in the plan and method of improving agricultural instruction and in the use of black-board drawings, specimens, etc.: also give lessons to a class before the Lecturer and their fellow teachers?

These suggestions were discussed and the results arrived at embodied in the following report:—

(1) With reference to the suggestion submitted to the Section, the definition of Agricultural teaching contained in (A) was generally agreed to. It was agreed that box and pot culture should not be confined to the upper standards of the elementary schools, but should be general. The number of plants and animals to be selected as subjects for object lessons should be left, it was decided, to the educational authorities of the various Colonies.

(2) With regard to the character and number of pictures and diagrams to be used in the elementary schools (B), it was agreed that suitable diagrams could be obtained from the National Society, from Messrs. Moffatt & Paige, Brown & Nelson, and others.

(3) With regard to question (C), it was moved by Mr. McFarlane, seconded by the Rev. Reece, and unanimously carried, that each member of the Section take away the question submitted, and, by the end of February, report to the Commissioner such suggestions as he may deem to be applicable to the Colony from which he is a delegate.

(4) On the question of the issue of higher certificates in agriculture to teachers in elementary schools in the West

Indies, it was proposed by Rev. Canon Simms, and seconded by Mr. Martin, that the issue by the Imperial Department of a certificate is highly desirable: that the Section adopt Mr. Deighton's suggestions [see Appendix]: that each Colony should arrange for the carrying out by its own officers of the preliminary examination and should report how far candidates meet the requirements (2) and (3) of Mr. Deighton's suggestions, and the Imperial Department should conduct the Final Examination of the approved candidates sent in by the Colony and issue certificates on the results. After considerable discussion, this was agreed to.

(5) With reference to the question concerning the preparation of Object Lessons, it was agreed that the heads of this question should be submitted to each member of the Section for further consideration.

(6) With reference to the question on Compulsory Education [see Appendix Question 1] the Section was of opinion that compulsion was desirable but not practicable in every Colony.

The Section then separated.

(Sgd.) W. P. BARBADOS.

January 6, 1902.

APPENDIX.

The following observations on the Minutes of the Educational Section of the Conference of 1901 were submittted by Mr. Horace Deighton, M.A., Head Master of Harrison College, Barbados:

QUESTION 1. [*Is compulsory education likely to advance the prospects of a successful system of Agricultural teaching in these Colonies?*]

With regard to Barbados, a clause was inserted in the Education Act passed in 1878 rendering education compulsory under certain conditions: but this clause has remained a dead letter, and I believe that those most in favour of compulsory education recognize that it cannot be enforced.

QUESTION 2. [*Would it be possible and desirable to open the Scholarships offered in certain Colonies to boys to go to English Universities in Agricultural Science as well as other subjects?*] The Barbados Scholarship can now be competed for by boys who take up Agricultural Science: this step would have been impossible without the assistance given by the Imperial Department of Agriculture. I am not in a position to say how far it may be possible for Demerara and Trinidad to adopt a similar course: but I believe that in addition to obtaining competent teachers, it would be necessary for those Colonies to change the examination by which their scholarships are now awarded. I quite agree that 'if a boy is to wait until he has reached a University before he specialises in Agricultural Science, he will

stand a poor chance of obtaining first class knowledge of the subject.' The difficulty mentioned by the Bishop which the examiners would have in awarding the Scholarships can, I have not the smallest doubt, be met in the same way in which they now meet the difficulty of deciding between a mathematical and a classical candidate for the Barbados Scholarship.

QUESTION 5. [*Is it desirable to ask the Imperial Department of Agriculture to issue certificates of competency in Agriculture to teachers in charge of elementary schools :*

(*1*) *On the results of examinations held by the constituted authorities in the various Colonies ;*

(*2*) *On actual experience (for one or more years) in school work ?*]

It was, I think, unanimously agreed that it is most desirable that there should be a uniform standard of attainment for certificates in Agriculture throughout the West Indian Colonies. This certainly can only be attained by the Imperial Department of Agriculture undertaking the examinations by the results of which the certificates are to be awarded.

As it is essential that the certificates should be awarded to *real merit only*, it is also essential that the examination should be at once put on a thoroughly sound footing.

It was, I think, understood at the Conference that there should be two examinations (1) a preliminary examination : (2) a final examination, on the results of which the certificates should be awarded.

But no agreement was come to as to the requirements for admission to the preliminary examination. Mr. Reece proposed a measure, well suited I believe to Barbados, but which Mr. Blair explained could not be applied in Demerara. It seems to me that no hard and fast rule on this point can be made; but that the requirements of the different localities must be consulted.

Only those should be admitted to the final examination who :—

(1) Have passed the preliminary examination satisfactorily.

(2) Have, since passing that examination, attended a course of lectures on Agriculture.

(3) Have, since passing the preliminary examination, showed by their school teaching that they possess the necessary aptitude for teaching the subject successfully.

Undoubtedly an additional fee should be granted to every teacher holding a certificate, who teaches agriculture in his school.

(Sgd.) H. DEIGHTON.

THE REGULATION OF THE QUALITY OF EXPORTED FRUIT.

BY THE HON'BLE SYDNEY OLIVIER, C.M.G., B.A.,

Colonial Secretary, and Chairman of the Agricultural Board, of Jamaica.

One of the most important mutual purposes of those who are met in this Conference is, or should be, the establishment of an assured market for perishable fruits in Great Britain and North America. This object is already of pressing concern to some of our islands and may be of substantial interest to all. The difficulty of transport has for long been a bar to the development of such trade, but we have now increasing reason for confidence that this difficulty may soon be overcome, as it has already been for Jamaica, in regard to our access to both these great markets. When, however, this difficulty is removed it will still be found that exporters have to deal with another, which has been experienced, I believe, by all producers of perishable foodstuffs whenever they have begun to try to dispose of large quantities of such produce in a new foreign market.

THE HARM DONE BY BAD PACKING.

The character of this difficulty is well indicated by the following extract from a letter lately addressed to a Jamaica shipper of oranges and grape-fruit by his London consignee. It is typical of many such that I have seen or heard of.

'We duly received your shipment of oranges and grape-fruit as advised. We are glad to say that the oranges turned out in very much better condition than previously. They were well packed and nice fruit, the best we have seen from Jamaica for some weeks. We succeeded in selling them as follows. . .

'These prices show an average of 7s. a box, and though this is a very poor return we believe it is the highest price that has been obtained for Jamaica oranges for some time past. We think we explained to you recently, that owing to the very bad condition in which the arrivals have come to hand, large proportions of each box being rotten, all the best buyers have been frightened off Jamaica oranges and will not touch them on any account. This is a most unfortunate circumstance and we trust that the losses that have been sustained by the shippers will make them more careful next season.'

This, then, is the situation we have to deal with. The problem will chiefly affect the future of our trade in oranges, limes, grape-fruit and pine-apples, and possibly hereafter mangos, in some or all of them. All West Indian Colonies may establish a profitable trade if they do not cut their own throats. The principal item is likely to be the trade in oranges, and we may, I think, deal with the conditions of that special trade as affording a sufficient text for our whole purpose.

PRESENT CONDITIONS OF THE ORANGE TRADE.

We have this great advantage, to start with: that from Jamaica, Dominica and other islands we can ship good oranges before the native American crop ripens in the United States and Canada, and before the Spanish and Mediterranean crop reaches England. We must take care that this advantage does not become a snare to us. It tends to become so because it induces packers to rush into the early market with shipments of immature fruit which, indeed, fetch high prices for a time, but which have been found to create a bad reputation for the quality and flavour of West Indian fruit in general, with the result that, as soon as any other supply becomes available, the bottom falls out of the market and our shipments will not fetch a price to pay expenses.

Again, not only is the reputation of West Indian fruit damaged by immature shipments, it has been damaged still more, from time to time, by consignments badly selected and carelessly packed. The bulk of the fruit now exported from Jamaica, and I apprehend from all other West Indian islands, is not produced on plants grown where a perfectly uniform sample can be culled and properly cured with slight handling before shipment: it is grown on what are usually self-sown trees, the fruit of which varies distinctly in quality, and it is got together hurriedly in head-loads, donkey-loads and dray-loads from ignorant, careless, or irresponsible contributors.

This fruit, uneven in sample, carelessly pulled, bumped about, pricked, bruised, the rind not properly dried and cured, is hastily packed in houses and sheds that are never properly cleaned and scoured during the season, and which become full of the germs of decay clinging to rotten cast-away fruit, mouldy paper and other trash, and ready to fasten on every scratch or wound of each fresh consignment.

THE ENGLISH AND AMERICAN MARKETS.

We have, as I have observed, two markets to deal with, and their characteristics are different. In the first place the United States market is protected by a heavy customs duty—a dollar and a half a barrel on citrus fruit. When I say that it takes 6s. a barrel to refund a shipper of the cheapest Jamaica fruit his expenses out of pocket, the immense handicap of a duty of 6s. 3*d.* will be manifest. The Californian growers are handicapped in the Eastern market by the cost of the long transport, but I think it probable that it will soon be found that the Florida planters are growing oranges to pay at a price of \$3.00 or \$3.50 a barrel, at which rate it would be impossible for any West Indian fruit even of equal quality to compete with them. Their pine-apples have a similar protection. But their early autumn market we can secure.

Apart from protection, very similar circumstances are observable in both the American and English markets in regard to West Indian oranges. In both they fetch good paying prices up to November or thereabouts, subject to

spasmodic collapses of price due to bad consignments disgusting the general market. In both markets after November, they are ousted, as regards the market for first class fruit, by Florida, California and Jaffa oranges, and, as regards the huge market for cheap and inferior fruit, by Spanish and Sicilian oranges.

This circumstance is what we have to combat; and, so far as the English market is concerned, where protection is absent, it can, I believe, be combated, for if all that London salesmen and tradesmen have told us is correct, it results from preventible causes. As regards the select market for fine fruit, giving from 1*s.* to 2*s.* 6*d.* a dozen retail price, which, though I call it select, is a very capacious market, certain shippers of established name and a carefully fostered special connexion can and do now hold their footing in that market. But these hardly count for our purpose. We have to hold the open auction market in which professional buyers supply the retail fruiterers, great and small, from week to week and from day to day. There is in our island plenty of fruit, and there might be (there soon will be where oranges have been attended to) plenty more, that is as good as and better than the Jaffa and California fruit that now ousts it from this market. I should not have ventured to assert this a year ago, because much of our fruit is by no means so attractive, but after a year's observation and discussion of this question in Jamaica, I say it with some confidence. As regards the ruck of the market, we certainly could from Jamaica, Antigua, Montserrat and Dominica, to speak only of the islands I know best, and I doubt not from the Windward Islands and perhaps Trinidad, with a very little selection and rejection, ship to England what would now be a finer fruit than the lower grade Spanish and Mediterranean, without costing us practically a penny to grow. It seems to me that if we make a profit of only 1*s.* or 6*d.* a box, that is worth doing, if we can do it on a consignment of a thousand boxes. But before we can venture on this scale we must earn the confidence of the markets. We must not have the retailers telling their buyers as now they do :—'Don't send us that West Indian rubbish at any price, we can't rely on it from one week to another.'

This want of confidence arises from several causes.

PRESENT FAULTS TO BE REMEDIED.

(1) Unsatisfactory characteristics in the quality of part of the shipments, as selling and eating fruit—that is, in appearance and condition; thick, rusty rind, tough rag and huge volumes of seed.

(2) Unskilful packing.

(3) Liability in the fruit to open rotten, or to go off quickly after distribution to the retailer.

All these dangers apply to pine-apples and every kind of perishable fruit as well as to oranges. They all of them are reducible and none of them irreparable characteristics of West Indian produce.

As soon as it is recognized that an available market for the fruit of a particular Colony is being spoilt by the bad quality of certain consignments (and this has occurred in past times in regard to Australian and Canadian fruit just as it is now occurring in regard to West Indian fruit) there promptly arises a demand for some protection of the careful shippers against the careless, and this demand has generally taken the form of a clamour for the intervention of the Law to prohibit the shipping of unfit or badly packed fruit, or to provide for inspecting, grading and marking fruit exported, according to its quality, by Government Inspectors.

THE CANADIAN FRUIT TRADE.

Proposals of this character have been much debated throughout the past year in Jamaica, and they have been still more closely debated in Canada, owing to the discredit into which the apple crop of the Dominion was brought by the bad shipments of the year 1900. The trouble was precisely the same in both cases, and the study of the debates of the Ontario Fruit Growers' Association on the subject is very instructive for us. The result of the discussions has taken form in an Act of the Canadian Legislature, passed last May, to provide for the marking and inspection of packages containing fruit for sale.

Before I discuss the provisions of this Law and the conclusions towards which we have gravitated in Jamaica, I must say that, in the first place, I do not believe we can ever eliminate great risks from the packing of oranges until we have full control of the fruit from the stalk to the wharf; that is to say, until we supply ourselves only from planted groves, or selected established orchards, the quality of whose fruit is uniform and from which the packer can handle it under supervision to the curing and packing house. Only at the packing house could any effectual subsidiary control be given, under sanction of Government or of association of fruit-growers. Any measures we may from this point be able to take, may be made applicable to pine-apples and any other kind of exportable fruit.

NEGATIVE CONCLUSIONS.

Certain negative conclusions, I think I may say, we have arrived at in our discussions in Jamaica, and they are in accord with the results arrived at by the Canadian fruit-growers.

(1) *That we should not attempt to forbid, by law, the exportation of any kind of fruit, however bad.* The second-rate green fruit is just the fruit that fetches the best price in its season, and we in Jamacia think it would be ridiculous to prohibit growers from selling at a high profit in September when they know that far better fruit will fetch nothing at all for them three months later.

(2) *That we should not attempt to give a positive Government guarantee of quality to all fruit exported.* It seems to me impracticable in Jamaica to inspect and certify, in any sense.

worth doing, an export of some four hundred thousand packages sent out within a few months. An unreliable government brand or certificate would do us more harm than good.

CANADIAN ACT.

Now let me read you the essential provisions of the Canadian Law*:—

'Every person who packs fruit in a closed package, intended for sale, shall cause the package to be marked in a plain and indelible manner, before it is taken from the premises where it is packed,—

(a) with the initials of the Christian names, and the full surname and address of the packer;

(b) with the name of the variety or varieties; and

(c) with a designation of the grade of the fruit.

'No person shall sell, or offer, expose, or have in his possession for sale, any fruit packed in a closed package and intended for sale unless such package is marked as required by the next preceding section.

'No person shall sell, or offer, expose, or have in his possession for sale, any fruit packed in a closed package, upon which package is marked any designation *which represents such fruit as of finest, best or extra good quality*, unless such fruit consist of well-grown specimens of one variety, sound, of nearly uniform size, of good colour for the variety, of normal shape and not less than ninety per cent. free from scab, worm holes, bruises and other defects, and properly packed.

'No person shall sell, or offer, expose, or have in his possession for sale, any fruit packed in any package in which the faced or shown surface gives a false representation of the contents of such package; and it shall be considered a false representation when more than fifteen per cent. of such fruit is substantially smaller in size than, or inferior in grade to, or different in variety from, the faced or shown surface of such package.

'Whenever any fruit packed in a closed package is found to be falsely marked, any inspector charged with enforcement of this Act may efface such false marks and mark the words "falsely marked" in a plain and indelible manner on such package.

'The inspector shall give notice by letter or telegram to the packer whose name is marked on the package before he marks the words "falsely marked" on such package.'

Inspectors are provided for, and fines for false marking.

The principle of these provisions is to identify the individual sinner and to enable us to bring home to him, both publicly and in his pocket, conviction of his sin: you can have as many or as few inspectors as you please: they will not be able to inspect all packages but they will be a terror to the evil doer,

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* 'The Fruit Marks Act, 1901.'

as they can condemn and brand his fruit as 'falsely marked' wherever it may be found, whether in the packing shed, in transport, or on the wharf. But if any packer chooses to mark his stuff as 'rotten,' 'green' or 'ungraded' he will not be interfered with, so long as the uppermost layer is as bad as the rest.

GENERAL CONCLUSIONS.

I will now briefly summarise my conclusions. There is in the United States, during the autumn months, and in Great Britain not only, I believe, in the autumn months, but throughout the year, a large and profitable market for West Indian oranges. There is a large market in Canada. This demand already exists and it depends chiefly on the West Indian planters and packers whether they will establish themselves in these markets or not. There is also a market for pine-apples, but the demand for them is not yet so well established. There ought to be a demand for limes, the merits of which as compared with lemons for household use require to be brought home to the British and Canadian housewife. There may be created a demand in Great Britain for grape-fruit, now better appreciated in the United States, and there is a possibility of a large market for mangos.

I suggest that it is worth the while of every West Indian Colony to secure itself a place in these markets, and that however rudimentary such trade may at present be, it is not too early to lay the foundations on which alone it can be built up.

SUGGESTIONS FOR FUTURE ACTION.

The first thing to be done, I believe, is for the Agricultural Society, or Chamber of Commerce, in each Colony, or the two in combination, to get all the fruit-growers and packers of that Colony to appoint from among themselves a special committee to act and make proposals in their common interest.

The steps to be taken by this committee, in concert, so far as legislation or executive action may be necessary, with the local government, should be, I suggest:—

(1) To establish a complete register of all growers and packers, and specially the registration of all packing houses and all shippers under licence, with a commercial licence duty. No person not registered and licensed to pack or ship.

(2) To require that all packages be marked with the packer's name and with a mark indicative of the packing house whence it issued. The packer may use any other distinguishing brand he chooses.

(3) To establish standard grades for size (a simple matter, dependent on the number of fruit to the box of standard capacity) and so far as may be possible in regard to other qualities—such as variety, when the variety is nameable and distinguishable; as to colour, distinguishing bright from russet fruit, and as to maturity.

We ought to take means to secure that these standards be the same for all West Indian Colonies, and I think we may have to ask for the assistance of the Imperial Department of Agriculture in establishing them.

(4) To provide for the appointment of local inspectors to check the quality of marked fruit by surprise surveys. The payment of such inspectors may be provided for by a small export duty—say, one cent a package, and by the packer's licence duties, and by the fines for false marking. The same funds could be applied to compensate packers for any loss through damage or delay to parcels by any action of the inspector when no fault is found on inspection. Such cases to be decided by the Committee. These inspectors should have control over the condition of packing houses, the licences of which might be cancelled on their adverse report.

(5) The Committee should have an agent or correspondent in the markets where the fruit is sold, who should send them prompt reports on the results of each public sale, giving the prices fetched by each packer's fruit and the reason for any failure. This would not be difficult to arrange, and the agent's fee should be a trifling matter, especially when there is a well organized Fruit Buyers' Association, such as exists in the United States, which itself conducts preliminary test inspections of all cargoes landed. The agent's report would be a check, subsidiary to that of the local inspectors, on the false marking of fruit. One agent would serve all the West Indies in each market. I believe that such arrangements as these would in a few years' time cure most of the evils from which our trade now suffers. It would drive reckless packers and shippers out of the market. Their names would be blacklisted by buyers, and they would have to mend their ways or go to the wall.

This would very much help those packers who now do their best, but who fail to control the quality of the fruit they buy. In Jamaica we do not now pack badly for the British market: we are injured by the treacherous keeping quality of the fruit, due to differences in the curing quality of the rinds of our mixed produce and to imperceptible injuries and bruises in handling. Defects of these kinds could not possibly be detected by the cleverest inspector, before shipment, even if he could control a shipment of three or four hundred thousand barrels transferred from the railway trucks to the steamer between sunset and midnight.

But with a rigid system of record and publicity not only the exporter but his neighbours will be able to learn pretty quickly what fruit and what methods of putting up to avoid, and the market will soon be supplied with only reliable fruit of declared grades.

I think these are the lines upon which we shall probably proceed in Jamaica, in regard to both citrus fruit and pineapples. We have a strong representative committee of the citrus fruit interests; we may, I believe, do a great deal without legislation, and we shall only ask the Legislature to step in and give effect to the proposals when this appears indispensable,

and when we have pretty well matured them by common agreement.

I strongly urge that fruit-growers and packers in all our islands should work without delay on somewhat the same lines. The wider the area of supply in regard to which the markets can rely on the same conditions and standards the greater will be the disposition of buyers to increase their confidence in that area of supply. If we mean to capture the big market in England we shall do it more effectively as a West Indian Province than as a number of comparatively insignificant competitors.

DISCUSSION.

Dr. H. A. A. NICHOLLS (Dominica): I have listened with pleasure to the extremely valuable paper read by Mr. Olivier, and I am sure that those engaged in the fruit industry of these islands will be grateful to him for suggesting a solution of the difficulties surrounding the question of regulating the quality of exported fruit. I was not aware that the conditions of Jamaica so nearly approached those of Dominica. I was under the impression that the fruit trade of Jamaica had so far advanced that the citrus fruits exported were gathered from cultivated groves: it would appear, however, that, as in Dominica, the fruit is gathered from trees that have grown up as self-sown seedlings, or have been planted in gardens and in odd corners of estates. The chief difference in the condition of the fruit trade in the two islands is that Jamaicans have the advantage of being able to ship their fruit in vessels specially adapted for carrying such perishable produce, whilst Dominicans have to be content with steamers in which there are none of the necessary arrangements for preserving the fruit during long voyages. It will be remembered that one of the recommendations of the Royal Commission was, that there should be established a line of fruit steamers between St. Vincent and Dominica and the United States and Canada. This is, I believe, the only one of the recommendations of the Commissioners that has not been carried out. Had Dominica better shipping facilities no doubt its fruit trade would greatly increase. As in the case of Jamaica, its greatest drawback at present is the shipping of inferior fruit, ungraded, and improperly packed by persons who purchase the fruit from peasants and others who take no trouble, and perhaps have not the necessary knowledge, to gather and carry the fruit so that no harm may happen to it. The greater part of the fruit shipped from Dominica is of this kind, and the reputation of the island's fruits suffers greatly. The valuable and able paper read by Mr. Olivier will do much good in Dominica when, later on, the fruit shippers of that island are afforded an opportunity of studying it. It will, I hope, induce the Government to take the necessary steps for initiating legislation to secure the

shipment of nothing but good fruit. It has been found in Dominica when fruit is shipped by planters who see to the careful picking, packing, and carriage of it that good prices are obtained in the home markets, whilst inferior stuff, packed and shipped carelessly, frequently results in a loss on the entire consignment.

The Hon'ble S. OLIVIER (Jamaica): I must explain that although I have spoken of the Jamaica orange trade as being chiefly dependent on fruit from wild or self-sown trees, there is in the island already a very large area finely planted in groves. This contribution is, however, only a fraction of the large export of Jamaica which, in the year 1900-1, exceeded a quarter of a million barrels, with 300 oranges to the barrel. At present not more than about one-half the available native crop is exported.

The PRESIDENT: Mr. Olivier's paper is one of the most important presented to these Conferences. It deserves to be widely distributed and to receive most careful consideration. Personally, I feel a deep interest in this matter. I brought forward the subject of regulating the export of perishable products in Jamaica in 1882, and last year, at a meeting of the Board of Agriculture, I urged that, as regards fruit, it was vital to the success of that industry. What has been done since, mainly, I believe, through the initiation of Mr. Olivier, is of so useful a character that the subject is now presented for the first time in a practical form. It is important to work in harmony with the shippers, but so as to encourage and protect the honest shipper and penalize the careless or dishonest shipper, with as little interference with legitimate trade as possible. The suggestion that the West Indies should secure agents in New York and London to look after their interests and furnish frequent reports, during the fruit season, is an excellent one. Such reports if regularly published in these Colonies would inform not only the exporter, but his neighbours, and it would soon be on record what class of fruit, as also the methods of grading and packing that have secured the confidence of buyers and obtained the best prices. It is evident that if we are to secure reliable markets for our fruit we must act energetically and unitedly. A confederation of the West Indies for the purpose of advancing their common interests, suggested by Mr. Olivier, could not fail to be of the utmost benefit to them.

SUGGESTIONS FOR CONTROLLING THE IMPORTATION OF INSECT PESTS.

BY H. MAXWELL-LEFROY, B.A., F.E.S.

Entomologist to the Imperial Department of Agriculture for the West Indies.

The question of preventing the introduction of new diseases of plants has formed the subject of discussion at two previous Conferences, and is brought forward again in order to throw light upon it from new points of view.

At the Conference held in January 1899, Mr. Fawcett read a paper dealing with this question, indicating certain ways in which the problem might be met. In the discussions that followed, at the Conferences of 1890 and 1900, many suggestions were made, and these were published in the *West Indian Bulletin* (Vol. 1, pp. 133, 309, 457) with a despatch from the Secretary-of-State, the laws then in force, and suggestions for a model Ordinance.

Since then the question has formed the subject of correspondence, and further information has been published. (*West Indian Bulletin*, Vol I, pp. 447-462).

The suggestions put forward included the prohibition of the importation of dangerous plants, goods, etc., the treatment of imported plants by fumigation, the establishment of quarantine grounds, and the inspection of all imports with the destruction of all plants found to be infested with disease.

This practically sums up what has been done during the past three years. At the present time Ordinances are in force prohibiting the importation of certain plants, goods, etc., in the following Colonies:—Jamaica, Trinidad, the Leeward and Windward Islands. The fumigation, on arrival, of imported plants is carried out in Jamaica only. It is evident that this question has not been adequately dealt with. There have been many suggestions and there is a limited amount of legislation, but I think all present will agree, that there is need of a more thorough and uniform system. A great deal remains to be learnt before we can attempt to deal thoroughly with plant diseases, but we are at least in a position to take steps to check the introduction of new diseases from abroad, and to limit as far as possible the diseases already found in these Colonies. There are two points of view which have been little touched on. These are, first, the pests that have been introduced in past times and those that are now liable to be brought in; and secondly, what imports are liable to be the means of introducing fresh diseases. It is on these two points of view that the following remarks are based. Before discussing the evidence I have to bring forward, I wish to define clearly what it is intended to do. In any scheme for controlling insect pests, there are two sharply separated lines

of work.* The first is to prevent the introduction of new diseases from any place outside the limits of each Colony: this includes not only importations from places not included in the British West Indies, but also between the various Colonies that make up the whole group. The second is to deal with the pests that already exist in each Colony. The measures that are now under discussion have nothing to do with the latter; we are to-day concerned only with preventing new diseases from entering any Colony from outside, either from abroad or from other Colonies. It is also necessary to put a clear distinction between the words 'foreign' and 'inter-colonial' imports. As 'foreign,' I class all imports from any place outside the British West Indian Colonies, thus including both distant countries and the Danish, French and Dutch West Indian possessions in this category. 'Inter-colonial' refers only to the imports received from any of the British West Indian Colonies.

PESTS INTRODUCED FROM ABROAD.

It is convenient to consider first, the pests that have already been introduced from abroad, that is, from places outside the West Indies. For this, we may take the scale-insects as our best example, since these have been very carefully studied both here and in many parts of the world, and since they constitute the most destructive group of insects at present known here. There are recorded from the West Indies 120 species (including varieties, but excluding all doubtful and un-named species): of these eighty-two are native, five are of doubtful origin, thirty-three are introduced.

We may again group our scale-insects in three divisions, as 'virulently destructive,' 'moderately destructive,' and 'rare and harmless.' For us, the first two only are of importance.

The following table shows how the native and introduced species are classed:-

Origin.	Virulently destructive.	Moderately destructive.	Rare and harmless.
Introduced	22	10	1
Doubtful	2	1	2
Native	8	25	49

Leaving the rare species out of consideration, we have sixty-eight species that are economically important, of which thirty-two are introduced as against thirty-three native; and

*Vide *West Indian Bulletin*, Vol. II, p. 318.

of the thirty-two scale-insects which are to be classed as virulently destructive, twenty-two are introduced species.

These figures show very clearly, for this group of insects, what we owe to introductions from abroad. In no other group can we obtain such accurate figures. It must also be remembered that scale-insects are more easily introduced than other pests, so that not only have we received many, in the past. but there are probably many more that will be introduced unless we take measures to check them.

In the case of insect pests in general, it is very difficult to speak accurately. There is very little information as to the pests of British Guiana, Trinidad and Jamaica. The common pests of the smaller islands are to some extent known: but it is in most cases impossible to trace their origin, both from lack of records and the fact that the pests of our crops have been but little studied elsewhere.

Of the hundred and odd pests that have come under my notice, twenty-nine appear to have been introduced, twenty-four are undoubtedly native, and the remainder are of doubtful origin. Even these figures show us that we owe a considerable amount to introductions from abroad, probably as much as we do to our own pests; and there can be no doubt that many of the pests, that now prove troublesome to agriculture here, need not have been allowed to enter had effective regulations been in force in the past.

INSECTS LIABLE TO BE INTRODUCED.

There is also the evidence as to the pests which are liable to be introduced from foreign localities, against which it is desirable to guard. This is a very wide subject, which cannot be treated otherwise than in a very general manner. There are over 1,200 scale-insects already known elsewhere, which are liable to be brought in; many of these are rare and so are not likely to be introduced, but many are well-known pests in other countries, and even in their native localities do damage. In this connexion we may remember that an insect, which in its native place never becomes abundant or destructive, may easily do so when introduced to new conditions. In its new locality the enemies which keep it in check in its home do not exist, and there is a great tendency for an introduced insect to become excessively abundant, even if only for a limited period. We are justified in looking with suspicion on all new arrivals in the shape of scale-insects or other insects, and may regard them all as most undesirable.

With regard to other insects, there is no end to those which might prove destructive here, but there is less chance of their introduction. Every crop which is of importance in these Colonies is in other countries attacked by a variety of pests not yet found here. The sugar-cane in Java, Queensland, Southern India, the Sandwich Islands and elsewhere has pests very different from our own. The same is true of cacao, coffee, citrus plants, sweet potato, grasses, green dressings and practically all important West Indian crops. The records of ento-

mological work in other parts of the world point to this more clearly year by year, and a very slight study of the pests of tropical and sub-tropical countries brings this point very forcibly before one.

Summing up the records of pests that have been introduced, and bearing in mind what dangers there are from casual introductions, we cannot doubt that there is a very real and immediate need of protecting the interests of West Indian agriculture from fresh pests; and the evidence I have attempted to condense in the previous pages offers a very practical and concrete example of what has been in the past, and may in the future, be effected by neglecting this point.

SPREAD OF PESTS FROM COLONY TO COLONY.

We may now pass to the evidence to hand of the danger from pests spreading from one Colony to another. We cannot here distinguish what pests have in the past spread from one Colony to another. Probably most of our introduced pests have been brought first to one Colony and thence distributed, and evidently there is a far greater likelihood of an insect being sent from one island to another than there is of its being introduced from outside the West Indies.

The following table has been prepared to indicate the distribution of the scale-insects in these Colonies :—

Origin.	Virulently destructive. (32)*	Moderately destructive. (36)	Rare and harmless. (52)	Total. (120)
British Guiana ...	14	5	5	24
Trinidad	22	6	17	45
Jamaica	29	22	26	77
Grenada... ...	21	8	7	36
St. Vincent ...	17	1	0	18
Barbados... ...	31	15	3	49
St. Lucia... ...	19	2	1	22
Dominica ...	21	3	0	24
Montserrat ...	17	6	1	24
Antigua	24	15	9	48
St. Kitts... ...	15	5	0	20

* These figures give the total known for the whole West Indian Colonies.

This table shows how many of our 120 species are found in each Colony, and they have been again classed according to the measure of their destructiveness. The figures cannot claim absolute accuracy. The scale-insects of Jamaica have been studied by Mr. Cockerell, those of Trinidad were collected by Mr. J. H. Hart, Mr. Lunt, Mr. Broadway and Mr. Urich, and those of British Guiana are very incompletely known from various records. In the smaller islands they have been very carefully studied, with the help of the Curators of the Botanic Stations, and the figures may be taken as giving an approximately true picture of the present state of things.

These figures show how well distributed are the most destructive species, and if we remember that of these, twenty-two (out of thirty-two) are introduced species, we can see how much these Colonies each owe to the inter-colonial spreading of virulent species, probably introduced first to one or at most to a few of these Colonies. If we accept the above figures as representing the present state of things, we can draw up a complementary table to this showing exactly what each Colony has to fear, that is, what species there are in the West Indies which are not yet introduced to each Colony, but which are at any moment liable to introduction.

	Virulently destructive. (32)	Moderately destructive. (36)	Rare and harmless. (52)	Total. (120)
British Guiana	18	31	47	96
Trinidad	10	30	35	75
Jamaica	3	14	26	43
Grenada	11	28	45	84
St. Vincent ...	15	35	52	102
Barbados ...	1	21	49	71
St. Lucia... ...	13	34	51	98
Dominica ...	11	33	52	96
Montserrat ..	15	30	51	96
Antigua	8	21	43	72
St. Kitts	17	31	52	100

The table on the preceding page represents, as it were, the danger each Colony has to fear from its neighbours, who may send it scale-insects, and though, as before, the figures cannot be taken as exactly accurate, they do represent, approximately, the present state of affairs. In visiting the different islands I am constantly struck by the absence of certain species of scale-insects which in other islands are very destructive, and, whilst I have no doubt as to the dangers from inter-colonial introductions, I have here attempted in these tables to bring the facts graphically before this Conference.

PESTS OTHER THAN SCALE-INSECTS.

For insects other than scale-insects, there are the same difficulties as before, but I have made an attempt to show the distribution of the worst in these Colonies. The important insect pests that have come under my notice amount to thirty-five. The number found in each island is given in the first column of the following table, and in the second column is given the number in each case (out of the whole thirty-five) which could do damage in each island: thus cacao pests are of no importance in sugar islands and therefore are not reckoned in these islands, and so on.

DISTRIBUTION OF PESTS OTHER THAN SCALE-INSECTS.

	Present number recorded.	Total number to be feared.
Grenada	9	22
St. Vincent	7	24
Barbados	15	30
St. Lucia	5	32
Dominica	9	31
Montserrat	2	32
Antigua	11	30
St. Kitts	2	29

This table shows clearly the unequal distribution of our pests, and also the number that would probably be found destructive if they were generally distributed. In these cases there are some of sufficient interest to be worth special mention.

Cacao. The cacao beetle is recorded from British Guiana, Trin-

idad and Grenada. It does not appear to be found in St. Lucia, Dominica or Jamaica.

The cacao 'thrips' is found in Grenada, St. Vincent, St. Lucia, Dominica and Jamaica.

Citrus plants. The citrus bark borer is found in Grenada Barbados, Dominica and Antigua.

The citrus weevil borer is known only in Grenada.

Jamaica has a distinct pest in the orange weevil.*

Coffee. The coffee borer of Nevis appears to be a most formidable pest, not as yet found elsewhere.

Sweet Potatos. The large weevil in Jamaica, the small weevil in Grenada, Barbados and Antigua.

Red spider in Barbados and St. Vincent.

Potato moth in Barbados and Antigua.

Central American rubber and *Bread-fruit* trees have a formidable beetle borer in Grenada.

Plantains and *bananas* in Dominica have the plantain weevil.

Arrowroot in St. Vincent is ravaged by the 'arrowroot skipper,' found also in Barbados.

The above are special cases that illustrate this matter very clearly, and we may also add the special pests such as parasol ant, guava fly, and army worm offered by Trinidad, and the mango maggot, and three army worms offered by Jamaica, with many other cases, continuing indefinitely into pests of very minor importance. Without careful study it is not easy to appreciate the importance of this point. Evidently our common pests are not yet completely distributed among these Colonies, and it will be wise to confine them to as close limits as possible.

IMPORTS.

Having thoroughly considered the dangers there are from the importation of insect pests from abroad and from their spread between these Colonies, we may turn to the imports and see what is the medium of introducing these pests, that is, what are the imports with which we have to deal. A return was prepared in each Colony (except Jamaica) showing the imports of plants, fruit, vegetables, etc., during three months, and there are certain facts to be deduced from these returns. I am regarding them as representing, approximately, a fair average of the nature and amount of the imports for the whole year for each Colony. On summarising them and tabulating a list of the actual vegetables, fruit and plants imported, they are found to fall under forty-three heads for foreign imports, and thirty-eight for inter-colonial. These may each be divided into two classes. There are those to be used solely for food, and these I regard as being unlikely to introduce disease; and there are those likely to be used for planting and which are liable to introduce disease. The former constitute

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* E. S. Panton, 'Insect and other pests of Citrus trees'. *Jamaica Bulletin*, January 1902, p. 14.

the 'safe list,' the latter the 'dangerous list.' Evidently there is, for our present purpose, a great distinction between a barrel of oranges to be sold in the streets and immediately consumed, and a box of seedling orange plants destined to be taken direct to an estate and planted out. Any insect disease on the one is unlikely to become established, since the oranges are at once unpacked and sold; whilst any insect pests, either on the orange plants or in the box, are likely to be let loose under favourable conditions on the estate.

I think we are fully justified in recognizing this distinction into classes. Amongst those imports that would figure on the 'safe list' would be the following: Oranges, bananas, avocado pears, golden apples, sugar apples, cocoa-nuts, eddoes, yams, peas, potatos, tannias, water melons, turnips, onions, limes, eschalots, carrots, etc. We are in a position to draw up a fairly complete list of these, distinguishing them from the 'dangerous list,' which would include all living plants, cuttings, suckers, and all parts of plants intended to be grown, as well as such special articles as we know are likely to be dangerous when coming from certain places.

In practice it is not possible to separate rigidly all imports into these two classes; but we can readily distinguish those that are known to be likely to import disease: we can also distinguish all that are unlikely to do so, and the remainder can be classed as circumstances and the available evidence permit. By thus dividing the imports, the question comes into a far more reasonable and practical compass. Anyone would hesitate to formulate a scheme to deal with all imports, from the apparent magnitude of the subject; but it is far easier to deal with the dangerous articles which constitute a portion only of our imports, allowing the bulk, (foodstuffs, etc.,) to pass unhindered. For the moment we can neglect all articles on the 'safe list' and confine ourselves to those constituting the 'dangerous list,' which are what we propose to deal with.

DANGEROUS IMPORTS.

Dangerous articles will include the following:—

All living plants, cuttings, suckers, etc., which are intended to be grown.

Canes may be regarded with suspicion as being likely to spread the scale-insects which appear at present to have a limited distribution in the West Indies.

Sweet potatos. These are, in Jamaica, infested with one weevil (found also in Florida and Queensland), and in Barbados, Grenada, and Antigua with another. It would be most unwise to spread these pests.

Pine-apples from Jamaica, Antigua and Dominica, should not enter other pine-growing localities, and foreign pines should be rigidly excluded.

Cocoa-nuts, if unhusked, should be excluded.

Guavas from Trinidad and possibly other localities.

Sapodillos from Barbados, and

Mangos from Jamaica are not desirable importations.

Green peas in the pod are unsafe, as also are

Plantain and *banana* suckers from Dominica.

The above are examples of what would figure on the 'dangerous list.' For each Colony the list will vary, according to the crops grown and the pests which occur. It would be useless to check the introduction of pests, already prevalent, or of pests which attack crops not grown in any particular Colony; but after taking these considerations into account, we can probably draw up a fairly complete list of 'dangerous' imports for every Colony in the West Indies.

The origin of the imports will naturally affect their liability to introduce disease, and we may at once discriminate foreign and inter-colonial imports. Those from foreign localities come from England, Canada, the United States, the foreign West Indian Colonies, South America, and Central America. These may be treated apart from the inter-colonial, that is, those from the British West Indies.

MEASURES.

We have now reduced our subject to small and compact limits: we have to deal only with imports on the dangerous list, both foreign and inter-colonial. The measures we can adopt to deal with these appear to be reasonably simple. Power is required in each Colony:—

(1) To prohibit any special importations.

(2) To destroy infested imports on arrival.

(3) To treat imports by fumigation or in such other way as will not lower their value.

Under the first, the importation of all or any plants, goods, etc., will be absolutely prohibited: it may be necessary to prohibit importation from a special locality or prohibit the importation of certain articles, wherever they may come from. Should such articles arrive they will be destroyed, or not allowed to be landed. This applies chiefly to special cases, as for instance, if a virulent disease of cacao was found in any West Indian Colony, all cacao-growing Colonies would prohibit the importation of plants, etc., from that place. At the present time all Colonies north of Trinidad might prohibit plant importation from Trinidad, owing to the parasol ant, and Barbados should prohibit the importation of sweet potatos from Jamaica.

Under the second, anything arriving infested with disease would be destroyed. This measure has only a limited application, owing to the difficulty of recognizing diseased plants as such; but it could be applied in special cases, and generally, if any suspicion attached to a particular importation it would be destroyed at once, or after an inspection by the most competent person available (for instance, the Curator of the Botanic Station).

Under the third, all imports on the dangerous list would be fumigated, unless their importation was prohibited. Thus

living plants would as a matter of course be fumigated with hydrocyanic acid before leaving the wharf.

Of these three measures, the first two apply to special cases only, whilst the third aims at preventing the chance introduction of any disease whatever. Should there be any pests which would not be known and dealt with under the first two heads, the third would automatically effect the desired result.

This scheme is based on the supposition that we are now in a position to advise what imports are safe and what are not. This knowledge depends entirely on an acquaintance with the pests now found in the West Indies, and with the crops and general conditions of West Indian agriculture. The scheme has also the advantage that by admitting the bulk of important foods without hindrance, few obstacles are placed on the run of trade, and the subject is brought within practical limits, whilst the discrimination of dangerous articles will still effect the result aimed at. Any theoretically perfect scheme would hinder trade; and it remains to secure the maximum efficiency in keeping out disease with the minimum hindrance to trade. This scheme is also not a hard and fast one, but can be gradually adopted after careful consideration of the needs of each Colony. It will be sufficiently uniform to safeguard the whole West Indies, whilst taking into account the various conditions obtaining in the different Colonies. There will be no large mass of material to deal with, and a small fumigating house at the chief port of entry will suffice for most Colonies. From time to time the regulations can be altered, provided there are the general powers mentioned above, and the responsibility of settling the details would be taken from the hands of the Government of each Colony and placed under the control of those specially qualified to advise.

This subject has been under discussion for a considerable time, and we appear to be as yet no nearer a conclusion. Jamaica alone has taken practical steps, and other Colonies should profit by the experience obtained there with fumigation. In many parts of the British Empire this question has been solved and measures have been adopted. Wherever agriculture occupies a prominent place, the introduction of disease is recognized as a danger, and the interests of agricultural industries demand a safeguard against it. With the work that is being done against insect pests in the West Indies, there should be the necessary measures to keep out fresh ones, and the time seems fully ripe for a realization of some general scheme.

I am fully convinced of the necessity of some such scheme as I have formulated, and from having a closer knowledge of the insect pests of the West Indies and of foreign places, I realize the more keenly the danger there is in the absence of these measures and the loss that may be incurred by the neglect of them. I trust the subject may be well discussed and that in the near future it may be possible to take decided action. The question calls for a thorough investigation of the insect pests of all the West Indian Colonies; but the knowledge we already possess of these, and of the imports

fully warrants us in starting a practical scheme. As our knowledge widens and becomes complete, the details of the initial scheme may be modified little by little; but I feel that until there are some safeguards against fresh introductions of disease, the work now being done against insect pests must be incomplete and only partially effective.

DISCUSSION.

Dr. H. A. A. NICHOLLS (Dominica): It is always an intellectual treat to listen to a paper read by Mr. Lefroy; but, on this occasion, he has, I think, surpassed himself. In listening to his remarks I was much struck by the analogy that exists between some of the diseases of man and those of plants. Mr. Lefroy has pointed out the interesting fact that when a pest, not serious in its native country, is introduced into a new country it sometimes proves most destructive. There are analogous cases in regard to diseases of man. I need only instance two, namely, the introduction of small-pox amongst the North American Indians, and measles amongst the Polynesians. In each case the disease spread with rapidity and virulence, and the death rate was exceedingly high. Mr. Lefroy has shown in a graphic manner, that many scale-insects are common to the various West Indian islands, but he has not pointed out that these pests are unequally destructive in different Colonies. Some years ago Professor Riley, the Entomologist to the United States Government, and the greatest authority on entomology of his time, visited Montserrat to inquire into the question of the scale-insects that were killing out the lime plantations in that island. He afterwards came to Dominica, and I had the advantage of examining many lime trees with him. He saw on the Dominica lime trees all the scale-insects he had found in Montserrat, but whilst these pests were destroying the Montserrat trees, they were practically doing no harm in Dominica, for the reason that the rainfall was greater and the scale-insects had enemies that killed them rapidly. Therefore, in tabulating the pests found in the various islands, their harmfulness or otherwise should always be noticed.

Observation has convinced me that the greatest danger of introducing insect and other pests is not by plants sent to Botanic Stations, where they are carefully examined and dealt with, but by visitors and others who are constantly carrying garden and other plants amongst the Colonies. [Dr. Nicholls then gave instances of blighted plants brought, in this way, without hindrance into Dominica.] If cigars or other goods are imported into an island they are stopped at once and examined by the Customs officials for revenue purposes. And it will be for Ordinances, to be passed by the various Governments, to create a kind of botanical custom house in which all plants and fruits can be stopped and examined so as to prevent the introduction of diseases that may spread rapidly and seriously affect the prosperity of the country.

The Hon'ble W. FAWCETT (Jamaica): In Jamaica we have had, since 1884, a law authorising the Governor to prohibit, by proclamation, the introduction of any plants or seeds, or to frame rules regulating their importation. Proclamations have been issued from time to time, with regard to coffee and plants from Central America, and last year a very important proclamation indeed was issued forbidding the introduction of any plant whatever from any part of the world, except at the port of Kingston, and there only after fumigation. The Agricultural Chemist is responsible for carrying out the work of fumigation. [*West Indian Bulletin*, Vol. II, p. 344].

The PRESIDENT: Will you be so good as to describe to the Conference how the process of fumigation is carried out?

Mr. FAWCETT: A small chamber has been built on the wharf for dealing with large quantities of plants, and a box, for fumigating small parcels that come by post, is placed at the Government Laboratory. The articles are fumigated by hydrocyanic acid gas. The actual cost is very slight. The Chemist fumigates the plants at his discretion: for instance, a case of plants coming from Kew, would not, probably, in his opinion require treatment.

Mr. J. H. HART (Trinidad): Several attempts have been made in Trinidad to obtain legislation on this subject, but up to the present we have not been successful. The Agricultural Society is in favour of a regulation, and the matter is still under the consideration of the Government. It is generally considered that we have so many insect pests in Trinidad that it is scarcely possible to introduce any new ones. The greatest difficulties should be placed in the way of any possible introduction of pests, and I hope to see a fumigating house established. The plant imports have been examined during the past year, on several occasions, but all were found free from pests, or affected only by those already common in the island. The greatest danger is, in my opinion, to be anticipated from American, East Indian, and Australian importations.

The PRESIDENT: I am hopeful that, as the result of this and former papers prepared by Mr. Lefroy and the experience that has been gained at Jamaica and elsewhere, we shall be able to establish a regular plan for fumigating plants before they are admitted into any of these Colonies. That appears to me to be the only effective way of protecting our crops and assisting the cultivators to obtain the best results from their efforts.

As you are aware this matter has been under consideration for years and it has also been submitted, officially, to all the Governments in the West Indies. We have now, I believe, educated public opinion to the point of showing that the proposals we have put forward are practicable and effective and calculated to be of great benefit to the agricultural interests of these Colonies.

PREPARATION OF CITRATE OF LIME IN THE WEST INDIES.

The substance of the remarks which the Hon'ble F. Watts addressed to the Conference will be found in his paper in the *West Indian Bulletin*, Vol. II., pp. 308-318. It was deemed advisable, owing to the immediate importance of the subject to the lime-producing islands, to publish the information at the beginning of the year rather than to keep it back until the present time.

Mr. Watts pointed out that there are three alternatives before the lime planter, namely, the preparation of concentrated juice, citrate of lime, or citric acid. In the West Indies, at the present time, the first is exclusively followed. The method is simple but there is considerable loss in preparation, and the exportation of the bulky liquid product necessitates expensive packages and heavy charges for freight. By the preparation of the solid citrate of lime a great saving is effected in the cost of packages and carriage, and in fuel. There is also less loss in manufacture. On the other hand, very considerable expense would be entailed in making the change from the one process to the other.

Mr. Watts described the process of manufacturing citrate of lime, carefully pointing out the practical dangers to be avoided, and in conclusion said :—

Under these circumstances the West Indian producer, in deciding which article he shall make, must ascertain the difference of cost of production and whether the buyers are likely, at an early date, to prefer one article to the other. As matters stand at the present moment I anticipate that citrate will prove more expensive in preparation than concentrated juice; the cost of erecting steam-heating apparatus and drying chambers, and of importing and transporting lime or chalk will more than counterbalance the saving of fuel, the reduction in cost of packages and the saving of acid destroyed in the process of concentration. Nevertheless, we have the evidence afforded by Italy and Sicily, the principal sources of supply, where the production of citrate is making steady headway, and where, I am informed, the process is found to be better and cheaper than simple concentration.

It seems to me highly probable that the manufacturer of citric acid will ultimately show a decided preference for citrate of lime; and this as soon as the manufacture of citrate in Italy and Sicily is placed upon a sure footing so that citrate, of uniform and dependable quality, comes steadily to market. When that point is reached citrate will begin to command higher prices than concentrated juice. West Indian producers will then have to produce citrate if they wish to obtain the best prices for their goods. This time may not be far distant, for the experiments of the last thirty years have removed most of the difficulties which were encountered, while during the last ten years the advance has been very marked on the commercial side.

DISCUSSION.

Dr. H. A. A. NICHOLLS (Dominica): The question brought before the Conference by Mr. Watts has, for some time past, engaged the attention of the lime planters in Dominica, and experiments have already been made in the island in the manufacture of citrate of lime. Mr. Watts' paper is of peculiar value to lime planters generally; and, on behalf of those of Dominica, I beg to thank him for the able and instructive way he has dealt with the subject. The greater part of the lime juice now obtained from the lime estates in the island is shipped in a concentrated form, and from this crude material citric acid is made. If the manufacturing chemists of England and America prefer citrate of lime, the Dominica planters will have to make it. But their attitude just now may be described as a watchful one, and Mr. Watts' paper does not lead me to conclude that this attitude need be changed yet awhile. In order to make citrate of lime the planters will have to erect a new plant, and they will not break down their works and build others unless they are satisfied that the new product will prove more profitable than the old. It has been shown that both the concentrated juice and the citrate of lime are sold on the basis of the proportion of citric acid they contain, as determined by chemical analysis. There will therefore be no present benefit to the lime planters if they export citrate of lime in place of lime juice.

THE BANANA INDUSTRY IN JAMAICA.

BY THE HON'BLE W. FAWCETT, B.Sc., F.L.S.

Director of Public Gardens and Plantations, Jamaica.

THE BANANA PLANT.

The banana plant is not propagated by seed, but by young plants which bud from the underground stem or 'bulb,' as it is called, of an older plant. This bud at first gets all its food-material from the parent bulb, but very soon forms leaves and roots of its own. Its first leaves are very long and narrow as compared with those developed later. When the young plant is six or eight months old, it is about 9 or 10 feet high, and its own bulb is 8 or 10 inches across. This is cut clean away from the parent, and the roots trimmed off. It may be planted as it is, but for convenience of carrying, and to prevent its being blown over before its roots anchor it, it is cut down to within 6 inches of its bulb. This bulb soon shoots, both from the centre, and from eyes all round. One shoot takes the lead, monopolizing most of the food-material supplied from the bulb, and this leading shoot is known henceforth as the plant—the others are its suckers.

ROOTS.

The roots push out in all directions horizontally, and some, from the base of the bulb, vertically downwards. The main roots are fleshy, not forming wood, but of the same thickness throughout like stout cords. They do not branch, but short thread-like roots grow out, and on these are the hairs which do the work of absorbing liquid from the soil. If a heavy wind shakes the stem the thread-like roots are torn off, and perhaps even the cord-like roots are broken, and the effects are noticed for the following three or four months in the bunches coming small.

Cutting the ends of the thick roots appears to encourage the growth of the thread-like roots.

The roots generally do not seem to have the power of adapting themselves, like the roots of many other plants, to overcoming difficulties. On meeting a large stone they do not feel their way under or over it, but apparently become injured. If the soil is either too wet or too dry, they decay; if they are cut through, they burst out at the severed end into numerous branches of equal thickness, which continue to grow in much the same direction. They do not approach the surface nearer than about 2 inches, and the depth to which they descend, depends on the nature of the soil, modified by deep cultivation and drainage. Under favourable conditions the horizontal roots will be found at a depth of 2 feet 6 inches from the surface, and the vertical roots from the base at a depth of 4 feet 6 inches. They grow rapidly, when the soil is rich and in good tilth, at a rate of 2 feet in a month for vigorous roots starting from the bulb. I have traced them to a distance of 17 feet from the stem, but their length depends on the encouragement, as it were, that they receive for extension.

The evidence afforded by their structure, points to the soil best suited to them,—a deep loam, well drained, but retentive of moisture from containing a large proportion of humus.

STEM.

The underground 'bulb' is the storehouse of food-material which is used up in the formation of roots and leaves and in their growth, in the formation of suckers, and finally in the development of the flowering shoot and the fruit. If a sufficient supply of material is not stored up in the bulb when the flowering shoot is in process of formation, the bunch will only bear a few 'hands.' This want of stored material may be due to various causes: the roots may not have been able to do their work properly, the leaves may have been damaged, or new suckers may have been allowed to drain the parent.

When a bunch is cut, or naturally, when the fruit has ripened and dropped, the leaves and stem decay while the food-material in them passes down into the bulb. Thence, very slowly and gradually, it finds its way into the bulb of the succeeding plant. The old bulb and its heir, the newer bulb,

are connected by a large surface, and threads of communication pass from one to the other. The connexion may last and continue on to a third, a fourth, or a fifth new bulb. The older bulbs are a provision against accidents, giving up their treasured store, as it were, grudgingly, so long as the young plants have roots and leaves by which to supply themselves.

LEAVES.

Compare the leaves with those of the cocoa-nut, which are divided naturally into ribbons so that they seem to enjoy the stormy winds of the seashore. The leaf of the banana shows very clearly that it was developed under conditions where only gentle breezes lazily move it, and as the structure of the root points to a forest soil as the cradle of the species, so the leaf indicates an open glade sheltered from the rough winds by surrounding woodland. Thus we get hints about situation, and the advisability of leaving shelter belts in clearing forest land. In exposed spots where the leaf is torn into shreds, it cannot properly perform its functions, and the consequence is that the bunch is small and of little value.

In an allied plant, the 'travellers' tree' (*Ravenala*), it is well known that it is possible to get a drink of water by piercing the hollow leaf-stalk; and a banana in a similar way collects the rain drops of a shower, and conducts them along the fluted leaf-stalk into the interior of the 'stem' which is nothing more than the sheathing bases of the leaves themselves. Water supplied in this way, and quite independent of the amount at the roots, is important for the proper shooting of the flower stalk.

The sheathing bases of the leaves act the part of a woody stem in supporting the huge leaf blades and carrying them upwards towards the sun light. They also enclose in their centre, and protect, the flowering stalk for the six weeks or so while it is pushing its way up from the underground bulb to the top of the stem. Immediately before the flowering stalk appears a small leaf is developed which hangs over and protects it on its birth from the direct sunlight.

The sheaths when cut across, show very large air-spaces, and these are connected with minute pores on the leaves which admit air, a large quantity of which is necessary.

FLOWERS.

If the flowering stalk is examined in the embryo condition in the stem, it will be found that the flowers are arranged in clusters disposed spirally round the axis. The clusters at the base of the stalk become the 'hands' of the fruiting bunch. It will also be found that the flowers in different regions of the stalk vary in the proportion of the length of the ovary to that of the rest of the flower. In those clusters which eventually become 'hands,' the ovary is two-thirds the length of the whole flower; higher up on the stalk are clusters in which the ovary is about one-half the length of the flower; and still higher, there is another series in which

the ovary is about one-third of the flower. These three sets of flowers, clearly distinguishable by the different proportionate length of the ovary are physiologically very different: those with the long ovary are female flowers and become the fruit, those with the short ovary are male flowers; and those with the ovary about half the length of the flower are hermaphrodite and form short, useless 'fingers' in the bunch. The problem of increasing the number of hands in the bunch must be attacked at a stage earlier than its appearance in the embryonic condition described.

VARIETIES OF THE BANANA.

There are several varieties of banana known in Jamaica, but the only one cultivated and exported on a commercial scale is that known formerly as the Martinique or Pouyat banana from the place of its introduction and the person who brought it over some time in the early thirties of the last century.* The Director of Kew Gardens has from time to time sent varieties to Jamaica, and we have received some also from Dominica which came originally from Kew. Many of these are spoken of in very high terms in the East, but so far, we have not found any that, for export purposes, rival the common Jamaican, although that known as 'Guindy' from Madras is considered good.

The red banana gets a high price in America, but merely as a decorative fruit for the table. The price is maintained by only exporting a small quantity.

The Chinese or dwarf bananas are grown in hilly districts, as they are not so liable to be blown over. This species is very productive, but is not suited for export to England as it does not keep well.

ANALYSIS OF BANANA SOILS.

The following analysis of soil from Portland by Mr. H. H. Cousins, the Government Chemist, has been published in the *Jamaica Bulletin* (October 1901, p. 150). It is reproduced here as an ideal soil for the banana:—

PHYSICAL ANALYSIS.

		Per Cent.	
	Stones	–	Fine Earth.
	Gravel	0·41	
	Sand	5·46	
	Fine sand	28·89	
	Silt	23·65	
Agricultural Clay.	Fine silt	13·77	
	Clay	2·72	
	Combined water / Organic matter	25·10	
	Total	100·00	

* See *Bulletin of the Botanical Department, Jamaica*, October, 1901.

	Per Cent.
Retentive Power for water	44

CHEMICAL ANALYSIS.

(Soil passed through 3 m.m. Sieve, dried at 100° C.)

Insoluble matter	27·870
Soluble in hydrochloric acid	72·130
Potash	·6796
Lime	1·379
Phosphoric acid .	2·760
Carbonic acid as Carbonate of lime ...	·600
Combined water and organic matter	25·100
Humus (soluble in ammonia)	0·86
Nitrogen	·7036
Hygroscopic moisture ...	24·860

FERTILITY ANALYSIS.

Available potash ...	0·0571
Available phosporic acid ...	0·0908

OBSERVATIONS.

This is a remarkable soil. It contains a large proportion of vegetable mould, and is yet possessed of a desirable proportion of fine soil particles. It is both free-draining and retentive of moisture. An ideal medium for the root system of the banana. The subsoil is porous and self-draining. The proportion of nitrogen and phosphoric acid is most extraordinary, the former being seven times and the latter thirty times greater than good average arable land in England. The available potash and phosphoric acid are both high. This is a typical specimen of a Jamaica soil specially prepared, as it were, for the kindly growth of the banana. I can suggest no manures as desirable or necessary, and conclude that cultivation alone will suffice for full crops of standard fruit for many years to come.

The following analyses by Mr. Cousins are given for comparison, as samples of soils in St. Catherine which grow bananas successfully :—

			A. Lawrence Field.		B. Rodens Penn.	
Humus		...	1·79	per cent.	1·54	per cent.
Nitrogen		...	·157	„ „	·147	„ „
Total	K_2O*	...	·3827	„ „	·4284	„ „
„	P_2O_5	...	·2124	„ „	·1868	„ „
„	CaO	..	·9996	„ „	1·5148	„ „
„	$CaCO_3$	...	·17	„ „	·42	„ „
Available	K_2O	...	·0518	„	·0108	„ „
„	P_2O_5	...	·0624	„ „	·0695	„ „

K_2O represents Potassium oxide.
P_2O_5 „ Phosphoric anhydride.
Ca O „ Calcium oxide or lime.
$CaCO_3$ „ Calcium carbonate.

These figures are calculated on the 'air-dried' soil and not on soil dried at 100° as usual.

CULTIVATION.

As a general example of cultivation I will take the case of an estate on the north side where the soil is a heavy loam, 9 to 15 inches deep, with the subsoil of stiff clay, and the rainfall 90 inches. The general operations would be as follows:—

For plants, start in January, plough 9 inches deep, throwing a furrow 14 inches wide. This plough will require a team of eight cattle to pull it. Two ploughs will do 8 acres a day. Harrow, and allow it to lie fallow till first week in March. Then plough and cross plough 6 inches deep, and harrow. Line 14 feet square. Dig holes 2 ft. 6 in. every way, and fill in with surface soil.

Dig suckers, beginning first week in February, one month before they are wanted, and only digging each week what can be planted each week a month later. Plant the second week of March to the end of April. Keep stirred with the plough 3 to 4 inches deep in fine weather, say every 8 weeks, but in wet weather simply bill with cutlass. Select the strongest shoot for the plant, which will fruit in the following February or March.

Prune off all suckers until June, then leave one sucker just coming out of the ground, which will fruit in the following April. In October leave another on the opposite side of the stem, which will fruit the following spring twelve months. In February leave another, which will fruit in 15 or 16 months.

On such an estate 66 to 70 per cent. of plants, and 88 to 90 per cent. of first ratoons should give bunches. Taking a seven-year period, the yield should be 330 payable bunches per acre per annum.

On the south side after lining at 15 by 15 feet, the irrigation canals would be laid out and water supplied to young plants every 5 or 6 days, to ratoons every 10 days, at the rate of 2 to 2½ cubic yards to each acre. No plough is used for the first three years on this light soil, but instead the hoe and the assam fork.

I will now go more into detail.

PREPARATION OF LAND.

Clearing.—In ground covered with forest or woodland some are content to cut down and burn, leaving the stumps to decay; but it is better, if it can be done, so to cut the trees that they will tear up their roots in their fall. The trees should be carefully selected, marked and cut up for their special uses—timber, posts, piles, tramway sleepers, firewood, etc. The underwood and brush can be used to burn up the roots and the trunks of useless trees such as Guango, Bastard Cedar, etc.

The ground should finally be carefully stumped. Even if the land is virgin soil and does not require ploughing, it is

better to stump at first. The plants can then be put in at regular distances at once,—an important matter in many ways; and if ploughing is necessary at a later period, there is no delay caused by digging out stumps. Stumping also facilitates cutting and carrying the fruit.

If the land is not the virgin soil of a forest, and especially if it be old cane land or pasture, it should be first thoroughly ploughed at least 9 inches deep, and harrowed. If the situation is on hill-sides where the plough cannot be worked, the pickaxe for stony ground, and the fork for soft ground should be used.

Distance.—The usual distance is 15 by 15 feet, or 14 by 14 feet, but these distances are modified according to circumstances, and planters are continually trying experiments with other distances. One planter finds that a hill-side of 15 acres on the north side planted 8 by 8 yields 8,000 straight, or more than 500 to the acre. Another, in a hot, flat district on the south side, finds it advantageous to plant 8 by 8 in order to shade the ground as soon as possible. It is stated by the advocates of close planting that the crop comes in sooner, that it can be regulated with greater success so as to come in during the five months of high prices, and that less weeding and less water are required. On the other hand, it will be found necessary to remove every alternate row for first ratoons, and probably for third ratoons to reduce the field to stems at distances of 16 by 16 feet. Where there is too much shade the bulbs are apt gradually to grow higher out of the ground with less hold against the wind, and the plants run up with a weak stem and irregular bunch. Another system is to increase the distance between the rows, and decrease it between the plants in the row, making the wider intervals run north and south. A planter who reaps 330 payable bunches per acre, planting 14 by 14, gets a yield of 400 per acre where he has planted 10 by 20 feet.

A planter who is planting cacao and utilizes the banana for shade, says that he has generally planted 14 feet square with cacao in the same line. If cacao is planted in the centre of the square, field implements, of course, cannot be worked either way, but by planting in the same line as the banana, they can be used for two or more years without apparent injury to either plant. However, he states that, after some experience, he thinks 16 feet square would be preferable both for banana and cacao cultivation, but there are considerations of locality, soil, fertility and so on which prevent a hard and fast line being laid down.

'In wide planting there is less risk of a falling tree carrying another with it. The roots of the banana appear to require a radius of at least 8 feet, and wide planting has always commended itself, in my experience, as the best agriculture; that is to say, sufficiently wide planting to give the plant or tree space admitting of its full and best development. Among other advantages cultivation is easier: and beyond question the higher the cultivation the better is the fruit obtained.'

Digging holes.—Some planters are content with shallow

holes about one foot deep. But better results are obtained when holes 2 feet 6 inches every way are dug: the roots get a better start, and a better hold on the ground, so that the plants are more forward, and are not so liable to be blown down.

A planter who prepares holes 3 to 4 feet wide and from 2 to 2½ feet deep, writes:—'It is not always possible to get the labour to make these holes, but I am convinced of the advantage and ultimate economy of making them large and deep, for, among other reasons, the plant gets a start at once; a good root is formed in the loosened earth which practically "anchors" the tree, and enables it to resist high winds, and when planted in this way, the tendency of the root to come to the surface is greatly obviated.'

PLANTING.

Time of year.—If the aim is to get the main crop in for the American market from March to June, planting is generally done from January to April. Otherwise planting may go on at any time when rain or irrigation water can be relied on to help on the young plants. There is no doubt, however, that March and April is the best time for planting when all vegetation is springing naturally. In April there are always showers which help to start the eyes of the bulb in putting out leaves and roots, and when the May rains come, the young suckers rush along faster than at any other time of the year.

Seed-suckers. Size. Suckers are selected for planting 6 to 8 months old: they would then be about 10 feet high, with large swollen bulbs 8 to 10 inches across. They should always be suckers which have not been pruned, and these are indicated by the first leaves being very narrow in proportion to their length, hence called 'sword' suckers.

Preparation.—They are cut down to within 6 inches of the bulb, and the old roots cleared off. Some planters put them in the ground at once, others leave them to dry for 3 or 4 days, and then plant. Others again find that they get better results by piling them in heaps 8 to 10 deep, then trash is thrown over them to keep off the sun, and they are left a month. The best way to pile them is to erect fences 3 feet 6 inches high to enclose a convenient spot 6 feet wide and of any length necessary.

Position.—They are placed in the ground with the eyes 3 inches below the surface. On hill-sides they are put in slanting, and an eye at the side develops into the plant. On the flat they are set upright; if the centre sucker happens to shoot it is left, if not, the best of those growing all round is selected. Some planters, even on level ground, plant their suckers slanting, as few eyes develop into suckers, and the strength is thrown into the formation of the bunch which is consequently finer; but the plant has not such a good hold of the ground, the bulb decays and leaves a hole, and the plant is liable to be blown over. The soil should be well drawn up over the bulb when planted.

IRRIGATION AND DRAINAGE.

Trenches.—The water channels should be close to the suckers when first planted, but when the plants are well established, the channels should be made in the centre of the rows, for if the water is applied close to the base of the stem, it encourages the production and growth of suckers, and in this way unnecessarily weakens the plant.

Drainage.—Perfect drainage is absolutely necessary for bananas. It is even more important to elaborate a system of drains for an irrigation district than to provide water-canals, for more harm is done by having too much water than too little. But drains are equally important on clay soils or subsoils when the water is supplied by the natural rainfall. On ground where there is not much fall the drains naturally follow the slope. But on hill-sides they should be made across the slope with only just sufficient fall to carry off the water: if there are natural gullies, the drains are led into them. In making drains it is a great mistake to make them too shallow from motives of economy.

CULTIVATION AFTER PLANTING.

Various opinions are held by banana planters about ploughing. Some who have planted in light, loamy soils have been reaping excellent crops for some years without any ploughing. Others, with heavy soil, plough every 8 weeks with a 6-inch plough, alternately one way and across. Others again plough only once a year.

My friend who is establishing a cacao walk with bananas before planting—ploughs, cross-ploughs, harrows and, when necessary, trenches, afterwards he ploughs with a small plough (with moon-coulter attached) three to six times a year. On banana lines, where a plough cannot work, he forks occasionally and hoes frequently. He says that the plough is far more effectual in breaking up the soil than any other implement he has tried, and it keeps the land clean much longer. The plough works from 4 to 6 inches deep, and the cultivator 2 to 3 inches. Another planter forks once a year, and uses the cultivator to keep the weeds down. When the grass is too high for the cultivator he uses hoes, and only substitutes the plough for the hoe or cultivator when labour is scarce. Both plough and cultivator are kept to 2 inches in depth in order to avoid destroying roots.

Keeping down weeds, maintaining a surface mulch, and loosening the soil, are all important matters in the cultivation of bananas as of other plants, and I am of opinion that a judicious pruning of the roots by the plough is also of great value, for as the roots do not naturally branch but grow straight out to great distances, pruning the roots induces branching at the severed ends, and a further production of roots from the bulb

A planter for whose judgement I have the greatest respect, writes as follows:—'I do not think that ploughing close to the banana and cutting through the roots does any harm. On the contrary, I am certain it does good—principally I think,

because the cutting gives fresh impetus to the roots, and this activity increases the growth of the plant. Take, say, potatos or turnips, which are usually grown in drills 27 inches wide: so long as a horse hoe can work in these rows it is good cultivation to keep working, even to the damage of some of the leaves. Every time it is put through all the roots crossing the drills must be cut, yet you see the greatest improvement in the growth of these plants.'

The following experiment, made at a banana plot in Hope Gardens, throws light on the subject of the formation of new roots induced by cutting them back. In planting the plot holes 3 feet wide and 2 feet deep were dug, the soil was returned to the holes and the suckers planted therein. The surrounding soil was ploughed and cross-ploughed after the plants began to grow. The soil is deep, rich, black, and rather heavy.

On November 19 a trench one foot wide and 2½ feet deep was dug half-way round a one-year old banana stool at a distance of 3 feet from the stem that was about to fruit, and the soil returned. In doing this the thick fleshy roots, some of them 5 feet to 6 feet long, were severed. No roots were found below 6 inches from the surface. Ten days later the soil between the first trench and 8 inches from the stem was removed to the depth of 2 feet 6 inches and returned, cutting off all the roots with the spade to within 8 inches of the stem. It was noticed when doing this that the roots that were cut off at 3 feet from the stem had thrown out numerous fibrous roots down their entire length.

A month later, on December 30, the soil was opened up from 3 feet inwards. New roots were seen to have grown out 3 feet from the stem down to a depth of 2 feet from the surface. These roots were carefully followed back to the stem: some proved to be new roots direct from the stem, whilst others had grown out from around the cut ends of the original roots, one root giving rise to five or six vigorous feeders.

Some of the cut roots did not grow at all but remained just as they were, except that they died back some 2 or 3 inches; this was more noticeable near the surface where they would come under the influence of dry weather. Some deeper ones had, however, rotted back a few inches, due perhaps to the ragged cut by the spade, or the root itself being injured at its junction with the stem by the pull of the cut.

The roots on the undisturbed side of the plant simply lengthened out a little and remained near the surface, 5 inches being the lowest depth at which roots were found.

The plant does not seem to have suffered any ill effects from the disturbance of its roots on one side.

In my opinion ploughing so as to cut the roots close to the stem should not be allowed when it is possible that the embryo bunch is being formed, as the stored food-material would be used to form new roots instead of being utilized in the bunch. How this loss of food-material affects the bunch we do not know,—whether it delays the shooting, or affects the size of the bunch or the fingers. This subject of the use of the plough

was discussed at the Banana Conference in Jamaica, and as a result some planters do not now plough except after the main crop for the American market is reaped, and not later than November.

Where ploughing is not the practice, the fork is used to great advantage when the young suckers are two months old.

Where the rains are constant, and the soil heavy, the cutlass is the best tool in weeding. The hoe and the assam fork and the cultivator are tools used under different conditions. The disc-harrow is an admirable instrument, and should be in constant use so long as the soil is sufficiently dry. If the ordinary plough forms a pan, a subsoil plough is used occasionally to secure good drainage.

TREATMENT OF SUCKERS.

Reason for Pruning.—Pruning away such suckers as are not intended to yield fruit is a most necessary and important operation. It should be done when the sucker is not more than one or two feet high. The larger the sucker grows, the more food-material it abstracts from the parent bulb, and the more its young roots interfere with the root system of the plant—in both ways injuring the future bunch.

Method.—Care should be taken when cutting away the sucker to apply the cutlass so that it does not point towards the plant, otherwise it is very easy to injure it. If the sucker is not cut away quite down to the white, hard part, it will soon spring again, and therefore time and labour are saved by doing it thoroughly at first.

Choosing and timing. Suckers shoot from the newly-planted bulb from eyes all round, and sometimes from the centre. Some planters cut away the central sucker; others leave it, as it gives a fair bunch if the bulb is vigorous. On the south side, in irrigated land, two or three suckers may be left at equal distances round the bulb. It is well to take those that start from eyes placed low down, so that the roots have a good hold on the ground. One sucker takes the lead, as a rule, and becomes the plant, fruiting in ten or twelve months; another comes in as a second sucker, giving a finer bunch four or five months later. Occasionally all the suckers will bear at the same time, when the bunches will not be so fine. It is the practice with some planters, on the north side, after planting in March and April for fruit in February or March to prune off all suckers till June, then to leave one just coming out of the ground which will fruit in the following April: in October another is left on the opposite side of the stem, and in February another which will fruit in fifteen or sixteen months. On the south side two suckers would be left instead of one in June, October and February.

Plants vary according to soil, situation, tillage, etc., in the time they take to produce fruit, but the usual time is ten months to shoot, and two and one-half to four months more to ripen. Ratoons usually bear in fifteen or sixteen months. Judging

from experience of his own estate, the planter can by careful pruning so regulate his banana walk when once established that the great proportion of the crop shall come in during the months of high prices, from March to June.

PRUNING LEAVES.

As the first leaves decay, they hang down all round, protecting the stem from the full glare of the sun. If they are cut away, the sheathing leaf-stalks on the outside of the stem dry up, and do not perform their proper function. It is well to leave them even in the shade of a banana walk unless it happens that the plants are clustered closely together, when too much shade causes the stem to lengthen out and become weak and brittle. In such a case some of the dead hanging leaves may be pruned away and some even of the living green leaves. In pruning the green leaves a semi-circular instrument is used mounted on a long handle; the convex edge is uppermost, and with this the leaf-stalk is partly cut through, when it falls over and hangs like one which has died naturally. Sometimes a leaf is seen to be growing through a bunch, and as it would, if left, cause some deformity or discolouration of the fruit, it is carefully removed from its position with the pruning tool. The hanging dead leaves should not be allowed to trail on the ground, as they encourage the production of roots coming to the surface.

HARVESTING.

When the bunch is to be cut, the stem is partly cut through 5 or 6 feet from the ground, and the bunch with the whole top of the plant topples slowly over. Care is taken that it does not fall against and injure any other plant.

The usual custom is to cut fruit by the hundred stems, each cutter by himself, without help, cutting the fruit with a cutlass and catching it. This is, perhaps, a doubtful practice, as owing to want of method, cutters running through the walks miss or roughly cut much of the fruit. A better plan is to employ a cutter and a helper who work together. The cutters with their helpers, twelve or fourteen in number, work in line, each cutter having three rows assigned him, or, in close planting, only two rows.

On some estates particular care is taken in harvesting: one man with his pruning tool cuts and manipulates the fall of the head, while another catches the bunch and when the stalk is cut, hands it to one of the women who are employed to carry it to a particular spot. This is necessary when we remember that a bunch weighs from 80 to 100lb. Here a book-keeper enters it in his book under its proper denomination as a bunch of 8, 7 or 6 hands, or he rejects it, if necessary, as not full enough, or too full. Several book-keepers on a large estate will thus be entering up the bunches, while the owner or the manager, riding from one to the other, controls the number cut for delivery that night or in the early morning at the wharf The bunches are wrapped in trash and handed up by

two men to another in a waggon, who packs them in carefully so that there shall be no bruising. It is singularly picturesque to ride through the shady rows of bananas, with here and there all round majestic heads falling, and figures moving swiftly at their work, --to note the quick movements of the men with keen upward glances, the stately walk of the women with a bunch balanced on their heads, all accompanied by the noise of the large leaves in their descent, the cries of the men, and the peculiar call for the women when they are wanted.

When the bunch is cut off, the head is completely severed from the stem 2 or 3 feet above where it was partly cut in order that the bunch might fall. Thus an elbow remains on the stem, and the whole is left to decay while the top part of the stem as well as the leaves is cut up into small pieces, with a cutlass. When both are fresh cut, a man can easily chop 100 stems a day. The chopped up stems are spread over the land which can then be ploughed without obstruction, while they help to manure it.

I have no doubt that if the head were not severed, but could be conveniently left to decay, a large proportion of the food-material elaborated and actually present in the leaves would pass from them down into the bulb, just as, in deciduous trees, the leaves send all that is of value into the stem before they fall off. This would be a decided advantage to the plant as there would be no loss of energy in working up again the mass which had been left to decay and to manure the ground, and the succeeding suckers would immediately benefit. But probably it would be very inconvenient to have the heads projecting into the passage ways.

I have been in correspondence about the value of the fibre of the cut stems. It seems that it could not compete with other fibres for rope-making, but it is possible that it may be of value as material for making paper.

REPLANTING.

It is considered advisable to re-plant a banana walk after an interval which varies from three to six years. A certain proportion is taken each year, so that every year some planting is going on. It is the custom with some to sow velvet beans and bonavist beans* in the field that is to be thrown up. These leguminous climbers soon cover up the old suckers and kill them, and after some time the whole may be ploughed up and re-planted. Some are trying planting between the rows of first ratoons, as it is easier to regulate plants and first ratoons for the American market than later ratoons.

The question of re-planting must be decided from various considerations: the field may be getting out of shape from the various ways in which the suckers have sprung from the parent plant, making it difficult to cultivate; the soil may require rest or a more thorough ploughing than can be given while stems

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* *Dolichos Lablab*, var. *albiflora* (Sem, Sim or Sembi of India.)

are growing; and the commercial question of paying better to plant for the American market.

DISEASE.

In Trinidad the banana stems are said to suffer from the attacks of a fungus (*Marasmius*). A year ago Dr. Morris pointed out stems in Jamaica which he considered were affected by the same disease. However, after careful watching ever since by many of the largest growers, it appears that the disease is not likely ever to do any damage, under the circumstances obtaining in ordinary cultivation.

A planter who has great experience writes as follows:—

'With regard to the disease on the banana plant pointed out by Dr. Morris, I am of opinion that it only makes its appearance upon young trees that are growing on very poor or water-logged land. I have seen it in my fields repeatedly, but it has no detrimental effect on healthy trees.

'The sucker that it makes its appearance on is generally a weak one, which in any case would not be kept to come to maturity.

'I do not know whether the disease is a fungus or bacteria, but it seems harmless, as I find it plentiful in my banana walks upon such suckers as have suffered injury, but it does not attack the strong healthy ones. It seems to me to be the seat from which decay will start in a weak sucker first. Personally, I have no fear of its doing material damage.'

Another who has planting control of more estates than anyone else in Jamaica writes:—

'I am of the opinion that there is no real disease here. Unhealthy conditions can always be traced to soil, locality, or the cultivation they receive.'

COST OF CULTIVATION AND RECEIPTS.

In considering the cost of preparing land and of cultivation afterwards, certain expenditure. for instance, that on buildings, roads, fences, tram-lines, may well be entered as charges to be spread over a certain number of years.

In the irrigated district of St. Catherine, a fair average amount that should be allowed for preparation of land and cultivation until the bananas begin to bear, is £15 an acre, and the annual expenditure afterwards would be £10 an acre.

The yield ought to be at the rate of 225 to 230 bunches paid for per acre, and taking the contract price all the year round at £8. 15. 0. per 100, the receipts would average £20 an acre.

Whether the same price is paid for bananas throughout the year, or whether it varies as it does for the American market, the total annual receipts will for a number of years average double the amount of the expenditure.

In the banana districts of the north side, taking the average of the whole run of estates from Port Antonio westwards to

Rio Bueno, the cost to bring an estate into bearing would be about £10, and the maintenance afterwards £7. 10. 0. The yield may be put down at 175 to 180 payable bunches per acre.

I have been favoured by a banana planter with the following abstract of accounts for one year. It refers to an estate of 200 acres in an irrigated district on the south side. The details will be useful to those who are thinking of going in for the cultivation :—

EXPENDITURE.

	£	s.	d.	£	s.	d.
Cultivation.						
Preparing lands	11	13	1½			
Lining		15	0			
Planting	1	12	6			
Trenching	5	4	1½			
Forking 240 acres	52	10	4½			
Stumping		4	6			
Weeding 775 acres	252	18	5			
Pruning...	75	1	0			
Propping	1	11	3			
Suckers: carting, supplying, etc.	26	17	8			
Manure	1	11	10½	429	19	10
Irrigation.						
Cleaning trenches	11	18	1½			
New trenches	3	16	3			
Irrigating	124	19	9			
Water rates	176	2	2	316	16	3½
Removing Crop.						
Cutting and carrying ...	205	8	7½			
Carting	123	3	11½			
Carriage by railway ...	206	10	1			
Wharfage	178	3	10½	713	6	6½
Supervision				203	12	6
Rent, Taxes, and Insurance ...				260	9	8
Miscellaneous.						
Fences, Carts, Posts, etc. ...	7	4	1½			
Roads	4	17	9			
Buildings	9	11	6			
Supplies...	16	8	7			
Tax on Coolies	19	3	0			
Headmen, Watchmen, Messengers	44	16	9			
Sundries	12	7	7	114	9	6½
				2,038	14	4½

BANANA ACCOUNT.

Bunches.	Eights.	Sevens.	Sixes.	Total cut.	Payables.
24,356	16,016	12,778	4,468	57,612	43,827

Average of payables out of total cut—76 per cent.

RECEIPTS.

	£	s.	d.
Bananas	3,589	13	5
Suckers	35	15	5
Miscellaneous	10	1	10½
Total	£3,635	10	8½

ON ANOTHER ESTATE.

The following selected details from a non-irrigated district on the north side will be useful by way of comparison. The soil is loose and gravelly without clay, rain 150 inches. Thirty-one acres were planted to produce a crop the following year. There were besides 135 acres yielding fruit, of which fifty acres were plants, and eighty-five ratoons :—

	£	s.	d.
Cleaning and preparing land ...	10	15	10½
Stumping	13	9	10½
Ploughing	43	19	1¼
Trenching	16	7	7¼
Procuring plants and forking ...	33	18	4¼
Planting	9	6	4½
Weeding 470 acres	148	3	4
Ploughing and harrowing 580 acres	121	13	4½
Pruning	28	6	4
Propping	5	16	10½
Reaping	78	17	10
Carting	12	5	3

The total expenditure was £1,250.

The payable bunches amounted to 40,916, or 303 to the acre.

The receipts were £458 from miscellaneous sources,—cocoa-nuts, cattle, cacao, and £2,210. 15. 3. from bananas.

I will now give an example of the receipts and expenditure on a portion of woodland of fifty acres of a pen which has been utilized for cultivating bananas.

The operations were commenced in October 1899, and the expenditure to date amounts to £1,312, which includes interest at 6 per cent., barracks of six rooms, purchase of suckers, and cutting down forest land.

The receipts month by month are given below :—

	£	s.	d.
1900.			
December	2	19	1
1901.			
January	7	17	11
February	31	19	9
March	154	4	11
April	526	2	7
May	425	15	6
June	367	5	0
July	185	12	6
August	97	0	3
September	84	9	11
October	128	18	11
November	75	0	0
December	68	0	0
Total	£2,155	6	4

A word of caution is necessary in considering the receipts. Every one who has had experience of growing bananas knows how a sudden 'blow' may level hundreds of acres of stems, and this may happen just when the bunches are ready for the harvest, and a year's work and expenditure are lost beyond redemption. The planter should therefore insure himself in some way so as not to be left stranded without money to carry on cultivation for another year.

BANANA DISTRICTS.

Number of acres under cultivation in bananas in the various parishes of Jamaica during the year 1901:

St. Andrew	165
St. Thomas	3,679
Portland	3,815
St. Mary	12,965
St. Ann	815
Trelawny	107
St. James	422
Hanover	370
Westmoreland	58
St. Elizabeth	32
Manchester	24
Clarendon	367
St. Catherine	6,163
Total	29,282

EXPORT.

During the last five years the exports of bananas have nearly doubled, as shown by the following table which gives

number of bunches and value to end of March in each year:

Years.	Quantities.	Values.		
	Bunches.	£	s.	d.
1901	8,248,485	618,636	7	6
1900	8,046,404	603,480	6	0
1899	7,497,281	468,580	1	3
1898	6,981,858	445,866	3	9
1897	4,838,645	302,415	6	3

The Direct Line of Steamers from Jamaica to England commenced running at the beginning of the year 1901. The following table gives the exports for the last nine months to December 28, as compared with those of the same months the previous year:

Countries to which Exported.	From April 1 to Decr. 28, 1901.	From April 1 to Decr. 29, 1900
United Kingdom	573,392	861
United States	8,146,493	6,496,300
Canada	1,505	3,393
Other Countries	1,778	1,428
Total	8,723,168	6,501,982

PRICES.

In England the best prices are obtained in March, April, May, and, later in the year, in August, September and October. Bananas from the Canary Islands average 5*s.* to 10*s.* per bunch packed in crates; those from Jamaica are sold as low as from 3*s.* 6*d.* to 5*s.* in order to encourage the sale. The rates paid by Messrs. Elder, Dempster & Co. in Jamaica are 1*s.* 9*d.* per bunch of at least 9 hands,—one of 8 hands being counted as three quarters of a bunch, and one of 7 hands as half a bunch.

The following were the wholesale prices in New York :—
1900.

August $1.00, September 90c., October 90c., November $1.00, December 90c.

1901.

January 90c., February 90c., March 90c., April $1.25, May $1.20, June $1.25, July $1.25, August $1.30.

The prices given by the United Fruit Company per 100 bunches to those who contracted to supply a certain number all the year round are as follows :—

January £6, February £7 10, March £10, April £12 10, May £12 10, June £11 10, July £7 10, August £5 10, October £6 5, November £6 5, December £5 10.

THE PREPARATION OF ESSENTIAL OILS IN THE WEST INDIES.

BY J. H. HART, F.L.S.

Superintendent, Royal Botanic Gardens, Trinidad.

As an industry, the preparation of Essential Oils has not hitherto been a prominent one in West Indian Colonies, but some little trade has been done, of which, it is probable, the island of Dominica must be credited with the greatest share.

In bringing the subject forward, I may mention that I lay no claim to expert knowledge and propose merely to point out some few of the essential oils which can be produced from material on hand, and to make one or two suggestions as to the future possibilities.

I have on the table a number of samples which I have prepared from material grown on the lands of the Botanic Department, Trinidad, namely :—

Citronella (*Andropogon Nardus*, var.)
Lemon Grass (*Andropogon Schoenanthus*)
Seville Orange (*Citrus Aurantium*. var. *Bigaradia*)
Sweet Orange (*Citrus Aurantium*)
Lime (*Citrus medica*, var. *acida*)
Lemon (*Citrus medica*, var. *Limonum*)
Mandarin Orange (*Citrus nobilis* var. *major*)
Clove (*Eugenia caryophyllata*.)
Pimento (*Pimenta officinalis*)
Bay (*Pimenta acris*)
Lemon bay (*Pimenta acris*, var.)
Eucalyptus (*Eucalyptus citriodora*)
Mace } (*Myristica fragrans*)
Nutmeg }
Camphor (*Cinnamomum Camphora*)

LEMON GRASS AND CITRONELLA OIL.

Lemon grass has long been known in the West Indies, but its relative citronella has only recently been introduced. The oil produced by these two grasses differs materially in character, and citronella obtains the higher price. My sample of the latter is newly distilled, but that from lemon grass is four years old, which accounts for the difference in colour. The export of citronella from Ceylon, from January to July 1901, is reported to have reached a total of over 600,000lb. weight, but at the same time it is stated that the price is falling. Of this total 300,000lb. goes to the United Kingdom, 200,000lb. to the United States, and appears to be mostly used for perfuming soaps.

CITRUS OILS.

Almost colourless oils of nearly the same specific gravity (·833 and ·837) have been obtained from the sweet and Seville orange, respectively. No attempt was made to ascertain the quantitative yield, as the available apparatus was too small to think of obtaining results on which calculations could be based. I may mention, however, that 100 fair sized oranges gave 1 oz. of oil. This I estimate to be much below the yield that would be obtained if operations were conducted on a commercial scale.

The oil of the Mandarin orange appears to be choice and distinct. Messrs. Schimmel & Co. in their report (October 1901) state: 'Commercial oil of Mandarin orange has up to now only been an unimportant article of consumption, because the price is high, and the genuine oil can only be obtained with difficulty, in small quantities.'

I exhibit two samples of lemon oil, one four years old and the other made last month (December 1901). The difference in colour is not due to age, but to defective distillation of the older sample, which has a dark colour. The oil of limes has been obtained from ripe fruit. Inquiries have recently come to hand for this oil, it being reported that market samples have been found largely adulterated.

CLOVE, BAY, EUCALYPTUS AND NUTMEG OILS.

The sample of clove oil was obtained from leaves and young flower buds taken fresh from the trees.

The oil of pimento was obtained from leaves of young trees raised from seed imported from Jamaica. So far as I am aware this tree is not indigenous to Trinidad, but the growth of young trees appears to show that it is quite at home in our climate.

Pimenta acris, which yields the bay oil of commerce is quite common in Trinidad and the trees yield an excellent oil.

Lemon bay oil is produced from the leaves of a variety of *Pimenta acris*, which is strongly lemon-scented. It has been ascertained by Messrs. Schimmel, by the analysis of a Trinidad sample, that this oil contains citral. The oil differs materially from 'bay oil,' and the quality of the

latter is considerably affected if any mixture of leaves occurs during manufacture. The mature leaves can only be clearly distinguished from those of true *Pimenta acris* by their odour.

The sample of eucalyptus oil was obtained from the leaves of *Eucalyptus citriodora*.

The samples of mace and nutmeg oils are four years old, and were distilled from refuse mace and wormy nutmegs which were unsaleable.

CAMPHOR AND OIL OF CAMPHOR.

The sample of crude camphor has been distilled from the wood of one of our garden trees. Some activity has lately been apparent with regard to this production. It appears that the Japanese Government has monopolized the camphor trade of Formosa, and there is considerable indication that a profitable industry will arise in growing the camphor tree outside of this monopoly. Some experiments have, I understand, been undertaken in Ceylon with the view to testing whether this is feasible. Our experiment shows that the trees grown in the climate of Trinidad contain a considerable quantity of camphor, but whether it can be produced in paying quantities has yet to be determined. I have no doubt that the members of the Chemical Section of this Conference will readily lend their aid in this direction.

That the camphor tree will readily grow in the West Indies is to be seen at the different Botanic establishments, and it can be readily propagated to any extent if required. Some of the trees planted at the Trinidad Experiment Station three years ago are now over 10 feet in height.

The oil of camphor passes freely under pressure from the solid matter. The trials made show that there is not so much camphor in the young branches and leaves as in the wood, and that more oil is yielded by the latter. There are said to be two different oils, and that from these are now manufactured the new chemicals, 'Disinfectol' and 'Insectol.' My authority for this is Messrs. Schimmel's latest report. I found the lighter oil, but did not find that of a heavier character.

EXPORTS FROM DOMINICA.

I am able, through the kindness of Dr. Nicholls, to give a return of the essential oils exported from the island of Dominica. I find that since 1891 they have exported £20,083 worth of distilled lime oil, £11,455 of otto of limes, £209 of orange oil, £3,587 of bay oil, and £12,688 worth of bay leaves—a total export for ten years of £48,022 or over £4,800 per annum. It is noted that the export of lime oil has been fairly steady, while the exports of bay and orange oils have fallen to next to nothing. The export from Trinidad is small, and we have no means of ascertaining the actual amount. Some demand has been made for bay leaves of late years, and considerable quantities have been shipped in the dried form. This class of export probably accounts for the falling off in the production of bay oil in

Dominica. On this point Messrs. Schimmel report: 'We now distil this oil at our works from material imported by us direct and supply it in all quantities.'

MIXTURE OF VARIETIES UNDESIRABLE.

I am inclined to think that one of the most promising of the oils is one which does not appear among the samples. I refer to Bergamot oil. A few years since I obtained from one of the best Italian districts, fruit of the best kinds of Bergamot, and have since obtained grafted plants. Our seedlings show a large amount of variation and will probably exhibit widely different characters in the fruit also. If this proves to be the case, it will not be wise to start with seedlings, as the character of the mixed oil would be sure to prove inferior, and grafting of selected kinds must be resorted to, as, I understand, is the Italian practice. If an Essential Oil Industry is to have a successful issue, I feel sure that it will be brought about by the careful selection of the best types of trees, and maintaining them true, by grafting or other processes; thus setting up a standard of quality which can be relied upon in the markets. At the present time the greatest complaints are that *few of the oils produced are pure*, being adulterated with inferior material. Messrs. Piesse and Lubin, in their work on perfumery, discuss the principle of the harmony of certain odours, and the discord of others, and I cannot help thinking that the mixing together of the produce of various kinds or varieties of seedling oranges would be likely to give oil of an inferior character. I exhibit a sample of a 'discord' or mixture in which it will be observed that the terpene odour predominates, although the several oils of which it is composed are excellent in quality.

Pending the establishment of selected varieties, the available material should be carefully sorted before distillation so as to have as little variation in quality as possible. There is an abundance of such material, at present going to waste, and large quantities of the best quality could easily be grown in most parts of the West Indies.

METHODS OF EXTRACTION.

The oils exhibited have all been extracted by distillation, in a small common still, but although produced in this simple manner, I believe them to be a fair sample of what it is possible to manufacture in this part of the world. Governments should I think be asked to facilitate the production of essential oils by every means in their power. One of the chief hindrances in many Colonies is the excise restrictions on the use of stills; but if it can be shown that there is room for a legitimate industry in essential oils, it is possible that some provision might easily be made to cover this difficulty. I may mention a few methods of extraction, other than distilling, such as by press, by sponge, and by the écuelle process. Parry, in *Essential Oils*, (p. 64,) states that an expert operator may make as much as 1½ lb. of oil in a day, by the sponge method. We have tried it in Trinidad, but did not make anything approaching that weight. The oil produced

was of excellent quality. To ensure this result, the hands must be kept clean while working. The écuelle process has not proved a success with us up to the present. Other methods of extraction are in use, but, as the details are intricate, and can only be brought into operation where mechanical skill is available, I do not propose to discuss them. I am of opinion that the sponge method is very useful for dealing with surplus fruits of the *Citrus* family by the West Indian peasantry, and a fairly remunerative industry, for those who cannot engage in field labour, might be instituted by its adoption. Valuable information on manufacture is to be found in Parry's *Essential Oils*, 1899, and in the *Odorographia* of Sawer. In connexion with other agricultural industries, the manufacture of essential oils would, I think, be fairly remunerative. It might be further encouraged by instructing people in the various processes, and providing depôts for the shipment and sale of the produce. I trust the matter may receive the attention it appears to deserve. I append the lists of exports from Dominica, kindly furnished by Dr. H. A. Alford Nicholls, C.M.G.

ESSENTIAL OILS.

Exports from Dominica, 1891-1900.

Year.	Distilled Lime Oil.			Otto of Limes.			Orange Oil Otto.			Bay Oil distilled.		
	Galls.	£	Val. ₱ gal.	Galls.	£	Val. ₱ Gal.	Galls.	£	Val. ₱ Gal.	Galls.	£	Vl. ₱ gl.
1891	1,359	680	10/-	*	...	...	...	...	...	107	403	75/
1892	1,095	466	8 6	32	98	61 3	...	...	...	...	...	,,
1893	1,064	678	12 6	282	1,198	85/-	26	125	96 -	61	229	,,
1894	1,153	577	10 -	316	474	30/-	...	...		122	458	,,
1895	580	290	,,	981	1,472	,,	15	23	30 -	152	570	,,
1896	1,265	1,093	31 6	677	1,371	40 6	27	61	45 -	434	1,627	,,
1897	2,607	4,204	32 3	277	509	36/9	..	...	..	66	247	,,
1898	3,331	4,011	24 -	227	421	,,	...	...	.	8	30	,,
1899	3,315	3,992	,,	272	500	,,	...	..	...	6	23	,,
1900	3,990	3,192	16 -	456	912	40/-	...	...	...	..	...	...
	19,759	20,083	...	3,520	11,455	...	68	209	...	956	3,587	

*Not distinguishable.

Bay Leaves

Exported from Dominica, 1891-1900.

Year.	Produce of the Island.		In Transit*		Total.		Value per Bale.	Weight per Bale.
	£	Bales.	£	Bales.	£	Bales.		
1891	366	293	100	80	466	373	£1 5 0	
1892	1,766	424	550	132	2,316	556	4 3 4	
1893	1,633	392	1,004	253	2,637	645	"	
1894	1,661	369	594	132	2,255	501	4 10 0	470 ℔. per Bale.
1895	2,173	483	801	178	2,974	661	"	
1896	1,480	329	864	192	2,344	521	"	
1897	1,147	255	675	150	1,822	405	"	
1898	1,373	305	873	194	2,246	499	"	
1899	662	147	634	141	1,296	288	"	
1900	427	95	50	11	477	106	"	
	12,688	3,092	6,145	1,463	18,833	4,555	...	

* Principally from Isles Les Saintes dependencies of the neighbouring French Colony of Guadeloupe.

DISCUSSION.

Dr. H. A. A. Nicholls (Dominica): Mr Hart has brought forward a subject of great interest, that should be followed up. Enormous quantities of essential oils and other perfumes are imported into England, mainly raised in the south of France. Much of this trade should be secured by our tropical Colonies, for there is no reason whatever why flower farms should not be established in these islands as they have been in a native state in Central India. Essential oils are the basis of all perfumes obtained from vegetable productions. These odorous substances are found mostly in the flowers, in the rind of fruits, or in the leaves. There are four

processes of extraction of the odours, known as 'expression, 'distillation,' 'maceration' and 'absorption.' In 'expression' the oils are obtained by powerful pressure, and, in the case of the citrus fruits, a machine is employed that ruptures the oil sacs of the rind. The machine in use in Dominica, Sicily, and elsewhere, is called an *écuelle*. It is a shallow copper dish with blunt spikes on the concave side, and a hollow receptacle in the handle at the lowest part. The fruit is rapidly rotated by hand and slightly pressed by the blunt spikes. The essential oil runs out of the ruptured sacs down the spikes and collects in the receptacle. In Dominica a very expert woman can by this process make over thirty ounces of lime or orange oil in a day. A penny an ounce is paid for the oil, but it costs more than this as there is a loss in the subsequent filtration.

In 'distillation,' the flowers, leaves, or other substances containing the oil are heated with water in a still, the whole mass being constantly stirred. The oil volatilizes and passes over with the steam and is condensed by means of the worm in a tank of cold water. In the case of the lime, the oil is forced out of the rind when the fruits are crushed for the extraction of the juice so that it is found in the lime juice, which is distilled to obtain the oil. Heat injures all essential oils, developing a turpentine odour, hence the distilled oil is less valuable than the pure otto, obtained by expression. From three to five ounces of the otto can be got from a barrel of limes by the *écuelle* process, and from four to six of the distilled oil can be obtained from the juice of a barrel of limes crushed in the mill. These two plans are the only ones in use in Dominica.

In 'maceration,' the flowers are mixed with equal parts of purified beef suet and lard made fluid by heat in the enter-bath or 'bain Marie' and then allowed to cool. The flowers remain for a day in the fat, which is then again melted so that the spent flowers can be strained off, fresh flowers are added and the process is repeated many times until the fat is very strongly scented. This is the pomade of commerce, and is shipped in tins. From these pomades, essences are manufactured by treatment with alcohol which takes up the odours readily from the fats.

The 'absorption' or '*enfleurage*' process is a cold one. The fat is smeared over glass bottoms of trays three inches deep, and the trays are then filled with flowers of very delicate odour. The trays with the contained flowers are piled up one on the other and left for twelve to seventy-two hours. The odours are absorbed by the fat. Fresh flowers are then put into the trays until the fat is sufficiently charged with the odour, when it is scraped off and packed for export. These processes are very simple and they might be employed for obtaining the rich perfumes from many West Indian flowers.

Besides the essential oil industry in Dominica, there was a considerable trade with the United States in bay leaves, which are used to make bay rum. During the ten years

1891 to 1900 inclusive, over three thousand bales of these leaves (each weighing about 470 lb.) valued at £12,688 were exported from Dominica to the States. About 1,463 bales valued at £6,145 were also shipped in transit (see Table, p. 176.) They were the produce of Isles Les Saintes dependencies of the French Colony of Guadeloupe. The Dingley tariff, however, has killed the bay oil industry and much reduced the exports of bay leaves.

The Hon'ble W. FAWCETT (Jamaica): Mr. Hart has shown a large and beautiful collection of essential oils. I have here a specimen of an oil which, as I expected, he has not brought, namely, that from the flower commonly known as 'Ylang-ylang' (*Cananga odorata*). It is, I believe, a valuable oil, and I intend sending this sample to England for valuation. The tree is easily grown in Jamaica and flowers freely. Should the oil prove of sufficient value I think we might be able to make some commercial use of it in Jamaica.

THE ALOE INDUSTRY OF BARBADOS.

BY WILLIAM G. FREEMAN, A.R.C.S., B.Sc., F.L.S.

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Any account of the aloe industry of Barbados is, of necessity, mainly historical in its nature, for, at the present time, a cultivated patch, of some half-an-acre in extent and a little boiling house, is all that is left to represent this once flourishing industry. The cultivation of the aloe for its juice was in operation at the time of Ligon's visit to Barbados. In his *History of Barbados*, published in 1657, he says (p. 98) 'Aloes we have growing here, very good and 'tis a beautiful plant; the leaves four inches broad, three quarters of an inch thick and about a foot and a half long: with prickles on each side, and the last sprout which rises up in the middle bears yellow flowres, one above another, and these flowres are higher than any of the leaves by two foot; these thick leaves we take and cut them through and out of them issue the Aloes which we set in the sun and that will rarifie it and make it fit to keep.'

Ligon's description of the plant cultivated in the seventeenth century applies very well to that grown at the present day. The illustration on the following page (Fig. 1) represents a typical, well-grown plant from the sole remaining cultivated patch. Barbados aloes is stated to have been first known in the London warehouses in 1693 (Fluckiger and Hanbury, *Pharmacographia*, p. 681.) Up to the present I have not been able to find any record of the introduction of the plant into the island. The identity of the species cultivated in Barbados does not appear to have ever been determined with certainty. At

one time it was definitely stated to be *Aloe vera*, Linn., of which *A. barbadensis* and *A. vulgaris* are synonyms. The identification, by Mr. J. G. Baker, F.R.S., of Kew, of the Curaçao aloe as *Aloe chinensis*, Baker, and its great similarity in appearance and character of its product to the Barbados aloe, made it not improbable that the Barbados plant is also *Aloe chinensis*. Complete specimens have recently been sent to

FIG 1. BARBADOS ALOES.
From a photograph.
(About 1/12 natural size).

Kew, and the result of their examination will be communicated later. There is no evidence to hand to indicate that more than one species has ever been cultivated in Barbados as a source of Barbados aloes.

As reference will be made from time to time during this paper to other varieties of commercial aloes, it may be advisable to indicate their botanical sources :—

Kind of Aloe.	*Yielded by*
Curaçao aloes. (usually called Barbados aloes in the market.)	*Aloe chinensis.*
Socotrine aloes.	*A. Perryi.*
Cape aloes.	*A. ferox* and other species.
Natal aloes.	*A. ferox* „ „ „

SOIL.

The aloes, taken as a group, are plants specially adapted for growth in poor soils and in dry situations. They are distinguished from ordinary plants by their fleshy leaves, containing large stores of water in reserve for periods of prolonged drought, by the enormously thick skin or water-proof coating of the vegetative organs, and by the deeply sunken stomata or breathing pores. These are amongst the characters commonly found in what are known botanically as *xerophytic* or 'drought-loving' plants. They are contrivances to reduce the amount of water given off by the leaves, and so enable the plant to exist in dry situations.

In Barbados there is an extensive tract of waste rocky land on the windward coast, particularly in the parishes of St. Philip and St. John. Windswept, exposed, and covered with only a thin and poor soil, this region offers conditions unfavourable to the majority of cultivated plants, but admirably suited to the requirements of the aloe. The general aspect of the district is shown in Fig. 2 This locality was formerly the headquarters of the industry. Since its abandonment the land has to a considerable extent dropped out of cultivation and the peasant inhabitants gain a precarious living from the sea and from the land, eked out by parish relief.

CULTIVATION.

Preparation of the Soil. The soil is well forked, freed from weeds and a good supply of pen manure is added. The land is marked out in beds with trenches between, to ensure thorough drainage. At the College estate at present the beds are eighteen feet wide, and run right across the patch.

Planting. The aloe, in common with many other plants of similar habit of growth, produces large numbers of little plants or off-sets around the stem of the parent. These can be taken off and used for planting. The aloe is so hardy that no particular precautions have to be taken in planting except to avoid very wet weather: at such times there is the possibility of the young plants rotting. A time when the soil without being very wet, yet contains sufficient moisture to allow it to adhere to the roots of the young plant, is the best. In Barbados, April to June are the months in which planting is usually done, immediately after the crop has been reaped. All that is necessary is to make a slight hole in the ground with a stick and set the young plant. No shade or special care of any kind is afterwards necessary. The sets are usually planted in rows, eighteen inches to two feet apart and six inches to one foot in the row.

Cost of Preparing Ground and Planting. The total cost of forking, weeding, manuring, and planting (exclusive of the original cost of the plants) is estimated at from $10 to $15 per acre.

If kept in good order and weeded, the first crop can be gathered in a year's time.

Subsidiary Crops. During the first year catch crops such as ochros, Indian corn, Guinea corn, yams, etc., are grown amongst the aloes. After this time they are done away with, and only the gourd vine, in the fruit of which the manufactured product is packed, is allowed to run between the rows.

REAPING.

In the early months of the year the aloes flower. No seed appears to be formed, the individual flowers shrivel and fall, leaving bare flower stalks. When the flowers have died and their stalks have withered and become brittle is the time for reaping. A number of wooden troughs (Fig. 2) V-shaped

FIG 2. REAPING ALOES.
From a photograph.

in section, are placed about the beds on moveable trestle legs, of unequal height, so that the troughs are tilted. At the lower end of each trough is an aperture. The cutters commence work very early in the morning. They gather up the leaves of a plant in one hand and with a knife in the other slice right through the plant about six inches above the base. The dripping leaves are immediately placed in a trough. The plant is thus left with its outer leaves cut through some six inches above their base, but the very young inner leaves are uninjured. In Fig. 2 the foreground shows rows of cut plants, the curious rosette appearance of which is, however, not well seen in the reproduction. The central bud continues the growth of the plant, the cut stumps of the outer leaves naturally withering and drying up. The cut leaves are piled up in the troughs as indicated, in many layers with their cut ends to one side. The juice rapidly exudes, and running down the trough is caught in collecting vessels, tins or

gourds, placed under the aperture. An expert worker will cut enough leaves to fill three troughs in half-an-hour. The leaves after the juice has exuded, are cast on one side, and made use of, to a certain extent, as manure. The reproach made against the Barbados cultivators in the *Dictionary of Economic Products of India* (Vol. I, p. 188) that 'this seems an unnecessary waste of material, since from these rejected leaves a most useful fibre could be prepared' is unmerited. It is possibly to be explained as due to some confusion in the popular usage of the word 'aloe,' species of *Agave* being often spoken of as Bombay and Manila aloes. The leaf of the Barbados aloe, at any rate, contains no fibre of any economic value. The leaf most readily tears across, and microscopic examination shows that it contains no fibre.

BOILING.

The collecting vessels are carried to the boiling house and, according to the amount of material in hand, either put on one side or boiled at once. The present boiling house on College estate, the only one, I believe, in working order in the island is a very small building divided into two rooms each about 10 feet square.

The boiling is done in an ordinary open copper pan or 'tayche,' of about 100 gallons capacity, fitted into a brickwork furnace and heated directly from below by a fire, the dried stalks of Guinea corn (*Sorghum vulgare*) being used as fuel, at any rate in the later stages. The juice as collected contains a certain amount of sedimentary matter which should be got rid of either before or during the boiling operation. If the former method is adopted, the juice is allowed to stand in a cask, often for one or two days, and the clear liquid drawn off from above. Otherwise it is boiled at once. The liquid is poured into the tayche and heated. During the early stages of the process a large ladle with a long handle is kept at the bottom of the tayche in which the sedimentary matter collects and is removed from time to time.

After the juice has once come to the boiling point, rapid boiling is maintained. Stirring is requisite to prevent charring as the mass concentrates. The liquid during the boiling process steadily thickens, at the same time becoming darker in colour. During its last stages very little heat is required, and the boiler-in-charge anxiously watches progress. The tests relied on to determine when the boiling is sufficient are very simple, and furnished by experience of the appearance of the boiling mass.

The character of the bubbles, small at first, large and glossy later; the rapidity with which a 'gloss' forms when a portion is splashed against the side; the time taken for the liquid to run off the stirrer, when dipped in and removed; and, perhaps the easiest for a novice to discern, the character of a thin film allowed to run down from the stirrer and dry. Such a film in the early stages is sticky, with continued boiling the stickiness gradually decreases, until when the moment for stopping the heating has arrived the dry film can be blown

readily from off the fingers. The juice, now extremely thick and viscid and almost black in colour, is removed, as quickly as possible, by means of the long-handled ladle, and poured into the gourds already prepared and placed conveniently near. The gourds are filled to the top, but on cooling the mass contracts a great deal, and they are usually filled up again from a later boiling. Each gourd will hold from twenty to sixty pounds of the finished product.

COST OF AFTER CULTIVATION AND MANUFACTURE.

The cost of the cultivation and the manufacture, since planting, that is to say, the care of the ground, weeding, cutting and boiling, is estimated at $25 (£5) per acre. The details for the actual reaping and boiling are calculated in units of gallons of juice. The price for cutting is twenty cents (10*d.*) per five gallons of juice, and boiling costs the same sum per 100 gallons of juice.

YIELD.

According to an estimate furnished me, the following was the yield per acre of prepared aloes:—

1st. year 100 ℔.; 2nd. year 250 ℔.; 3rd. year 500 ℔.; 4th. year 500 ℔.; 5th. year 450 ℔.; 6th. year 400 ℔.

According to another estimate the return is stated to be from 500 ℔. to 1,000 ℔. per acre.*

In practice the crop was formerly not retained on the ground longer than about the fourth year. The yield is stated to fall away after that time (possibly more rapidly than the above detailed estimate indicates) making it more profitable to prepare the ground afresh and plant again.

EXPORT.

The finished product was exported to a large extent in gourds, although larger packages were also employed. Most of the consignments passed through the hands of merchants in Bridgetown who bought the aloes, either directly or through an agent, from the smaller cultivators. In the following table the exports, as given in the official returns in the Blue Books, have been summarized, in periods of ten years, since 1843 the earliest date for which these returns are available. It will be noticed that by far the greater proportion of the trade was with Great Britain.

* J. Weatherhead, *Barbados Advocate*, January 28, 1901.

Export of Aloes from Barbados for the 60 Years 1843—1902.

Summarized in periods of ten years each.

Ten year Period.	British Isles.	United States of America.	Other Countries*	Total.
1843—1852	£33,059	£3	£184	£33,246
1853—1862	£12,185	£62	£6	£12,253
1863—1872	£13,568	£502	£101	£14,174
1873—1882	£2,640	£139	£277	£3,056
1883—1892	£134	£224	£42	£400
1893—1902	£35 *		..	£35
Total 1843—1902	£61,621	£930	£613	£63,164

A very marked feature in the returns is the extraordinary fluctuations from year to year. Thus in both 1843 and '44 the exports were over £7,000, falling in '45 to £3,800, rising in '46 to £5,000, to fall again in '47 to £1,000, whilst in '48, '49, and '50, they surpassed £2,000, yearly. These fluctuations were probably due to variation in demand rather than to great differences in the crop. Buyers speculated in aloes, purchasing it when cheap, and only putting it on the market as good opportunities arose. Disregarding these irregularities, the steady decline of the industry as shown in the table is very obvious.

Causes of Decline of the Industry.

The crude process of manufacture was undoubtedly one of the determining reasons of the decline of the industry. The merchants whose houses formerly dealt in aloes state that the great variation in quality made commercial transactions

* The greater quantity entered under this head was shipped to other British West Indian islands. All shipments have ceased since 1894, although the name 'Barbados Aloes' is not yet lost to the market. Cases of 'Barbados Aloes' figure in recent drug sales, but are usually Curaçao Aloes.

very difficult. In a consignment of say 100 gourds, the contents of no two would be, probably, of exactly the same character. Indeed in a single gourd the upper portion might be good aloes and the lower charred and almost worthless. No sample was of any use as representing the lot, but separate samples, indeed more than one, would be necessary of each separate gourd.

The method of boiling supplies a ready explanation of this variation. No two boilings would be evaporated down to exactly the same degree of concentration. Even more serious was the impossibility of securing the whole of one boiling at the proper point. With a fixed pan, heated directly over a fire, it is impossible, even with the greatest care, to obtain the upper and lower portions of the thick viscid mass in the same condition. And when it is remembered that only a ladle was used to remove it, the risk of the lower portion charring will be recognized. An adequate reason is thus shown for the extreme variation between the contents of different gourds and even between the different portions of the same gourd. Such differences were extremely damaging. Another fault, sometimes, at any rate, committed by the cultivators was to allow the juice to stand for some considerable time before evaporation. Fermentation takes place, and, after that, however carefully the liquid is evaporated, a dark coloured aloes is certain to result.

Evaporation should be begun immediately after the juice is collected. The juice evaporated at once is a very superior article, either by sun-heat or by steam-heat, but in an open copper over naked heat it would probably never fetch more than 25s. per cwt. Whilst the internal factors were thus adequate to harm seriously, even if not to destroy, the industry, external causes were at work which tended to lower Barbados aloes from its former position. The Dutch West Indian Islands of Curaçao, Aruba, and Bonaire, took up the manufacture of aloes, with the result that at the present time there is an over-production of Curaçao aloes. The out-put of Curaçao aloes fell off recently owing to an export duty. This has since been removed.†

MANUFACTURE IN OTHER COUNTRIES.

At this juncture, it is advisable to review the methods of manufacture of the more important other varieties of aloes. These methods are described in various works and it is not necessary to enter into any detailed account here.

In Curaçao and other Dutch West Indian Islands, the method of manufacture is practically identical with the Barbados method.* Steam-heat is recorded as being employed in Aruba.

Cape and Natal aloes are also evaporated rapidly by some-

* E. M. Holmes, (1) 'Aloes,' *Pharmaceutical Journal*, Vol. xx. p. 561. Jan. 18, 1890.
(2) 'Curaçao Aloes,' *Pharmaceutical Journal*, Vol. xxi. p. 205. Sept. 13, 1890.
and (3) 'Barbados and Curaçao Aloes,' *Pharmaceutical Journal*, Sept. 17, 1892. p. 232.

† *Trade of Curaçao*, 1899. Diplomatic and Consular Report, 1900. p. 10.

what similar crude methods. Concerning the famous Socotrine aloes, the accounts available from the ordinary text-books are very meagre. I am indebted to Mr. Holmes for the following account, taken from Prof. I. B. Balfour's *Botany of Socotra*. (p. xxxviii).

'The collection of the gum is a very simple process, and can be accomplished at any season. The collector scrapes a slight hollow on the surface of the ground in the vicinity of an aloe plant into which he depresses a small portion of goat-skin spread over the ground. The leaves of the aloe are then cut and laid in a circle on the skin, with the cut ends projecting over the central hollow. Two or three layers are arranged. The juice, which is a pale amber colour, with a slightly mawkish odour and taste, trickles from the leaves in the goat-skin. After about three hours the leaves are exhausted, the skin containing the juice is then removed from beneath them, and the juice is transferred to a mussock. Only the older leaves are used. The juice thus collected is of a thin watery character and is known as "tâyefrhiho," or watery aloes. In this condition it is exported to Muskat and Arabia and sells for three dollars the skin of 30 lb. By keeping however, the aloes changes character. After a month the juice by loss of water becomes denser and more viscid. It is then known as "tâyef-gesheeshah" and is more valuable, a skin of 30 lb fetching five dollars – whilst in about fifteen days more, that is, about six weeks after collection, it gets into a tolerably hard solid mass and is then "tâyef-kasahul" and is worth seven dollars a skin of 30 lb. In this condition it is commonly exported.'

A new variety of aloes has recently been introduced to the English market, namely, Uganda aloes. It arrived packed in various forms, chips, powder and bricks. The latter were wrapped in papers bearing the inscription 'all Crown aloes is sun-dried and is guaranteed absolutely pure.' * In character and tests it approximated to Cape aloes, and 'is apparently one of the purest and most carefully prepared aloes in the market. It has been sold at £5 per cwt.' †

The usual range of prices for the more important varieties of aloes is:–

Curaçao 25*s*. to 30*s*. per cwt.
Cape 25*s*. to 30*s*. per cwt.
Socotrine 70*s*. to 75*s*. per cwt. rising when scarce to 120*s*. per cwt.

Of Uganda Aloes I find a quotation later than that mentioned above and the price given then was only 23*s*. per cwt.

Of the three principal aloes of commerce, Socotrine stands conspicuously first in value. Socotrine aloes differ from the other two kinds in preparation, being sun-dried, instead of concentrated by artificial heat. In order to ascertain whether their mode of preparation was an important factor in determining

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* W. A. H. Naylor & J. J. Bryant, 'Uganda Aloes,' *Pharmaceutical Journal*, April 1, 1899.

† E. M. Holmes, 'Uganda Aloes,' *Pharmaceutical Journal*, March 11, 1899.

their value I consulted Mr. E. M. Holmes, who wrote: 'In reply to your inquiry, Socotrine aloes do *not* fetch a higher price *because of their more careful preparation,* since no aloe is so inferior in this respect or so variable. It is the intrinsic medicinal quality, the action being milder and less of an irritant nature. Good Barbados, or rather good Curaçao aloes, comes next in rank, and Cape aloes is considered in England only fit for horse medicine, although the cheaper varieties of Barbados aloes usually supplant it even for that purpose.'

As already stated, there is a large out-put of aloes from the Dutch West Indian Islands, sufficient, in fact, to flood the market. In consequence, there would be no likelihood of a remunerative industry being revived in Barbados, if only ordinary Barbados aloes were manufactured. The only possibility seemed to be to manufacture a high-grade aloes, of light colour and appearance. Two methods are open by which to obtain such a product, namely, evaporation by steam-heat, or sun-drying. Steam-heat demands a considerable expenditure on machinery, and as recommendations made now to revive the industry must be such that peasant proprietors can adopt, it is out of the question at present.

The remaining method of obtaining good quality Barbados aloes is by sun-drying. Wooden trays were made 3 ft. by 2 ft. 3 in. deep, of groove-and-tongue deal, some with joints caulked with pitch, and others with molasses and slacked lime, usually an excellent caulking material. These were filled with juice, to a depth of about 1 in. and exposed to the full sun. Unfortunately, the caulking did not stand the exposure, and the manager of the estate being anxious to secure his small crop boiled the juice in the ordinary way.

There seemed a possibility that the industry might be encouraged by the production of a good aloe, but on further inquiry it is found that at the present time the appearance of the drug matters little, so long as it is medicinally active. It is not bought directly by the general public, but indirectly in the form of pills and horse-balls. A few firms only want a certain amount of good quality liver-coloured aloes, and there is always sufficient to meet their moderate requirements from the Dutch Islands. One is reluctantly forced to the conclusion that there is no prospect of the Barbados aloes industry being profitably revived with the plant at present cultivated.* Whether or not it might be possible to do so by the introduction of the Socotrine aloes, *Aloe Perryi,* remains to be seen. This seems to be a somewhat delicate plant, and the accounts of its attempted introduction elsewhere are not encouraging. If it should prove unsuited there seems little hope for any revival of the ancient aloe industry of Barbados.

In conclusion I should like to place on record my thanks to all those who have so kindly placed their knowledge at the disposal of the Department, in particular to Mr. E. L. Hollinsed,

* At the time of the Conference I had hopes that there might be a profitable market for a good Barbados aloes, but the demand for such an article seems to be very small, and the low grade kinds are out of the question.

the manager of Society estate, the late the Hon'ble J. Gardiner Austin, M.L.C., Mr. J. Challenor Lynch, M.C.P., and Mr. J. H. Weatherhead. Above all I am indebted to Mr. E. M. Holmes, F.L.S., of the Pharmaceutical Society, London, who so kindly and generously gave me the benefit of his extensive knowledge and experience.

DISCUSSION.

Professor J. B. HARRISON (British Guiana): Sixteen or seventeen years ago, when in Barbados, I devoted considerable attention to the preparation of aloes at the Government laboratory, with satisfactory results. Since 1847 aloes have been prepared in the island in vacuum pans, but although fetching high prices its preparation was not profitable. On further looking into the matter we could not see our way to make it a commercial success.

Hon'ble F. WATTS (Leeward Islands): It must be remembered that Barbados and Socotrine aloes are not interchangeable but specific drugs, and therefore may have different values. As Mr. Freeman is aware these drugs can be distinguished by chemical tests, one from the other. I should like to know which drug is exported from Uganda,—Socotrine, Barbados, or Natal aloes? Doubtless we have before us to-day an instance of a small industry being lost by want of care and knowledge on the part of those engaged in it.

Mr. FREEMAN: Uganda aloes is stated to be very similar to, if not identical with, Cape aloes.

Mr. A. J. JORDAN (Montserrat): A small aloe industry was carried on in Montserrat about twenty years ago. The leaves were cut and stood upright in tubs. On the two succeeding days after they were first reaped a small portion was cut off the lower end of each leaf.

Dr. H. A. A. NICHOLLS (Dominica): I would like to ask Mr. Freeman whether he can say what is the degree of concentration employed in boiling down the juice of the aloe. About ten years ago when in Barbados I made inquiries into the aloe industry with the help of Mr. Bovell, and it appeared to me that the degree of concentration was about six to one.

THE PRESIDENT: The Hon'ble T. Kerr, who has just left the Conference, has informed me that when he first came to Barbados, about forty years ago, large areas of land in St. Philip were devoted to aloe cultivation, and that he understood the industry paid very well.

Mr. J. R. BOVELL (Barbados): I cannot add anything to what Mr. Freeman has said. No small proprietors cultivate aloes now in the island, although one or two persons in the neighbourhood of College estate may have a few plants.

Mr. W. D. SHEPHERD (Barbados): I have no doubt but that the failure of the aloe industry in Barbados was due to the

crude system of manufacture. With a better plant we might be able to revive it.

THE PRESIDENT: Can you suggest any steps which might be taken to encourage the industry?

Mr. W. D. SHEPHERD: If it can be shown that the industry is likely to be profitable, I think persons who formerly cultivated aloes would be glad to do so again.

SUGGESTIONS FOR THE REMOVAL OF EPIPHYTES FROM CACAO AND LIME TREES.

BY ALBERT HOWARD, B.A., A.R.C.S., F.L.S., F.C.S.

Mycologist and Agricultural Lecturer to the Imperial Department of Agriculture for the West Indies.

In dealing with the question of the epiphytic vegetation on cacao and lime trees in the West Indies, it appears desirable, at the outset, to define clearly what epiphytes are, before discussing in what manner they interfere with the vital processes in the trees on which they occur, and how they may be removed in the most economic manner.

Epiphytes are air plants which live upon other plants but not in a parasitic manner. Thus the lichens, mosses, liverworts, ferns, orchids, and wild-pines, which are to be seen on the stems of cacao and lime trees, especially in the higher and moister regions in the West Indian islands, are examples of epiphytes; and it is with these plants that the present paper deals. Besides epiphytes, which merely live on the surface of the trees in question and use them as supports, various other plants known as parasites, of a totally different character, are met with thereon. Some of these parasites (plants which live partly or entirely at the expense of the host) are flowering plants; for example, the common dodder (*Cuscuta*) and various plants known locally as mistletoe or 'Capitaine du bois' (*Loranthaceae.*) Others belong to that class of flowerless plants known as Fungi and cause definite diseases some of which, in the case of cacao, have been described elsewhere. (1) Parasites and epiphytes, therefore, are totally distinct. The former live partly or entirely at the expense of the host, while the latter merely attach themselves to other plants for certain purposes, for example, support, and as a means of obtaining light.

It was Schimper (2) (3) who showed that epiphytes are principally confined to the moist tropical forests, and have

(1.) *West Indian Bulletin*, Vol. II, No. 3, pp. 190-211.

(2.) Die Epiphyt: Vegetat: Amerikas—A. F. W. Schimper, Jena, 1888.

(3.) Ueber Bau und Lebensweise der Epiphyten West Indiens—A. F. W. Schimper,—Bot. Centralblatt XVII, 1884.

developed along definite lines in the struggle for light by being able to establish themselves vertically with very little expenditure of material. Speaking of Schimper's work, Mr. Percy Groom, in an obituary notice of this distinguished botanist, says :—

'Commencing as humble occupants of the soil within the shady forest, epiphytes had in the course of ages laboriously clambered up the trees, striving after the light and even struggling against the precarious and fluctuating supplies of moisture and of humus, inventing new absorbing and fixing organs and contriving fresh devices for resisting threatened death from thirst or starvation, until at length their perilous career was crowned with success and they formed aerial meadows, gardens, shrubberies and even forests. Schimper showed that the evolution of epiphytes was still reflected in the forest where the simplest epiphytes lurk low down in moist shaded crevices of the tree trunks, and the more elaborate ones are ranged successively upwards until even before the tree tops are reached perfection is practically attained' (*Nature*, Oct. 1901.)

Such a vertical distribution as is here indicated can be seen in the epiphytes on cacao trees in the higher and moister situations in Grenada, St. Lucia and Dominica. Lichens, liverworts and mosses are predominant on the main stems, while in addition to these, higher forms like ferns, orchids and wild-pines are largely confined to the upper branches. Indeed, it would appear that the profusion of this vegetation on cacao is one of the principal factors which limit the successful cultivation of this crop, to comparatively low elevations.

Before dealing with the methods of removing this aerial vegetation, it will be well to indicate in what manner these plants affect the health and bearing power of the cultivated trees on which they occur, or in other words, how they concern the planter. To understand this, it will be necessary to consider some points of structure and function in the cacao tree itself. If we examine with the naked eye the surface of the bark of a young and vigorous cacao tree or of a large sucker, brownish shallow depressions about one-eighth of an inch long will be seen in the bark which are arranged more or less in lines with their longer axes vertical. These are the pores of the bark (or lenticels), and it is by means of them that carbon dioxide and moisture are given out by the stem and oxygen taken in from the air. In a word, the lenticels of the cacao tree, like those of most dicotyledonous trees, are the channels of gaseous exchange between the air and the active cells in the interior of the stem. They perform therefore for the stem a similar function to that which the stomata do for the leaves. Recent researches have shown that the amount of carbon dioxide given out through the lenticels of growing trees is considerable. The gaseous exchange between the stem and the air is concerned in the physiological process known as respiration. The protoplasm of the actively growing cells in the stem, such as those of the cambium, and indeed in the whole plant, cannot work properly without a full supply of oxygen. Such cells give off carbon

dioxide as a product of the activity of their protoplasm, and both the incoming oxygen and the outgoing carbon dioxide pass either through the cortical pores or lenticels, or else through the bark itself when this is porous. Evidently, therefore, in order that a cacao tree may develop properly, these pores must be kept open. Anything which permanently blocks them up will interfere with the gaseous exchange, or breathing, as we may call it, and will therefore be injurious. That the epiphytic vegetation blocks the lenticels can easily be made out by a suitable examination. Lichens closely cover up and choke the lenticels over considerable areas, while the rhizoids of liverworts and mosses produce the same result. The larger epiphytes, like orchids and wild-pines, also cover the pores immediately beneath them, but the harm done in this way by these larger plants is not so great as that brought about by the dense carpet of minute cryptogamic epiphytes. Again, the presence of this vegetation on the stem tends to keep it moist and to saturate the lenticels with water, in which case the gaseous exchange or breathing is stopped. (4)

In the case of cacao, this interference with the fundamental physiological process of respiration however, is not the only harm done by the epiphytic carpet. It is a matter of common knowledge that cacao trees infested with these plants do not bear to anything like the same extent as trees which are comparatively free from them. It is only occasionally that pods are to be seen on the stems of these epiphyte-laden trees, so that it is likely that either flowers are not formed at all, or, if formed, are unable to penetrate the epiphytic covering or are destroyed while doing so. Even should some flowers make their way through, their chances of pollination are likely to be much smaller than those on normal trees. It will be seen, therefore, that from two points of view epiphytes are undesirable appendages to the cacao tree. A case is therefore made out for experiments designed to compare the cost of removing this vegetation with the value of the resulting increase of crop over that of contiguous untreated areas. It has been argued, that since epiphytes occur naturally on trees in the virgin forest, they cannot therefore do any damage to cultivated trees. The argument however is fallacious. In establishing, say, a cacao plantation, it is first of all necessary to get rid of the existing flora and then to establish a single species, (in this case cacao.) in its place. While this is being done, and afterwards, too, there is a continual warfare between the planter, acting on behalf of his cacao trees, and the inroads of the flora and fauna around him. If he relaxes his efforts his adversaries gain an advantage, and if he gives up the struggle altogether his cacao will probably go to the wall when allowed to compete with the vegetation around. The planter therefore has to fight all the forces of nature as it were, if he wishes to give his cacao trees the best chance and to let them work at their highest efficiency; and it is evident that, from this point of view—and this is the point of view of scientific agriculture too, any thing which interferes with their health and development is a pest.

(4.) *Physiology of Plants.* Pfeffer. (English Translation) 1900, Vol. I, p. 198.

It has now, I think, been fully shown, that both from the point of view of science and practice, epiphytes are likely to be harmful to cacao trees, and it is proposed to deal with their removal and to bring forward some methods of doing this which may be new.

THE REMOVAL OF EPIPHYTES.

The larger epiphytes such as orchids, wild-pines and ferns, are probably best removed by hand, and it would not appear to be difficult to keep these in check in new cultivations if care is taken to remove them periodically from the young trees. In old neglected fields it is more difficult, and here in cases where the trees are practically useless something might be done by replacing such trees by new suckers.

The smaller epiphytes which infest the stem offer greater difficulties to their removal than the larger ones just mentioned. At the present time they are removed by brushes, but it must be confessed the method is slow, costly, and not very satisfactory, since the smaller epiphytes are so constructed that any portion can live independently, and thus such plants readily grow again from the small pieces which are left, after cleaning, in the cracks of the bark. Again, there is a likelihood of the bark being injured by the brushes and thus the number of flowers borne on the stem diminished.

It occurred to the writer, while on a visit to Grenada in August 1900, that it might be possible to remove the epiphytic carpet by means of spraying with a solution of copper or iron sulphate.

The suggestion for using a solution of copper sulphate (blue stone) in destroying the common weed known as charlock (*Brassica sinapis*) in England was made in France in 1897, and in the two following years it was successfully demonstrated in various parts of England that a three or four per cent. solution of this substance, when applied in the form of a fine spray, would kill charlock without injuring the cereals among which it grew. (5) It appeared likely, therefore, that such tender plants as mosses and liverworts, and the fungoid and algal constituents of lichens might be destroyed with ease by such a substance as copper sulphate. It was not however till May 1901, that an opportunity occurred to test the efficacy of this substance. Preliminary experiments were made on cacao trees at the St. Vincent Botanic Station, in which the trunks of the trees were only covered with epiphytes to a slight extent. It was found that a four per cent. solution of the sulphate readily destroyed this vegetation and apparently did no harm either to the cacao trees or the pods thereon.

In August, last, further experiments were made with copper sulphate on badly infested lime and cacao trees at Copt Hall estate, Dominica, in which four and six per cent. solutions were applied with a spraying machine. Both these washes proved

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(5.) Destruction of Charlock—J. A. Voelcker, *Journal of the Royal Agricultural Society of England*, Vol. X. Third Series 1899, p. 767.

effective and the epiphytic vegetation was completely destroyed. Mr. Jones, the Curator, kindly visited the trees six weeks after the spraying and reported as follows:—

'There is no doubt as to the effectiveness of the sulphate of copper preparation. Wherever this was applied the moss is dead and some of the ferns have also been killed. In no case is any injury apparent to the lime or cacao trees operated upon.' (Sep. 25, 1901.)

In the same month the Dominica experiments were repeated at St. Lucia with washes of the same strength, and the results obtained were identical with the above, in spite of the fact that heavy rain fell after the application of the solutions. Mr. Moore, the Curator, who visited the trees a week after the spraying, reported that in his opinion the six per cent. solution of copper sulphate gave the best result.

Evidently, therefore, it is extremely likely that a wash has been found which may prove to be of economic value to cacao planters in freeing their trees from epiphytes.

Cost of Treatment.—On account of numerous other duties during the above mentioned visits, it was not possible to try the experiments on a large scale—indeed it was not possible to treat more than fifteen trees at one time with copper sulphate solutions. It was found, however, that half a gallon of solution, properly applied, is sufficient to treat a single tree. From this fact and Mr. Lefroy's experience in spraying cacao trees in Grenada (6) which were infested with thrips and in which both pods and leaves were treated over considerable areas, it is possible to arrive at a probable estimate of the cost of treating an acre of cacao with copper sulphate. Assuming that the rate of spraying stems with copper sulphate solution is approximately the same as that of treating both pods and leaves with insecticide, it follows from Mr. Lefroy's figures that four men with two knapsack spraying machines could treat an acre of 300 trees in a day. The cost therefore, using a six per cent. solution of copper sulphate at the local price of eight cents a pound in Barbados, is:—

	$ c.
4 men at 30 cents	1.20
150 gallons of 6 % copper sulphate* ...	7.20
	$ 8.40

The initial cost of two knapsack spraying machines would be $22, but since every cacao and lime estate should possess these, their cost cannot be properly put down to this operation

(6.) *West Indian Bulletin*, Vol. II, p. 189.

* A six per cent. solution of copper sulphate means one in which 6lb. of the sulphate are dissolved in 100 lb. of water. Since one gallon of water weighs about 10 lb., the solution can be made by dissolving 6 lb. of copper sulphate in 10 gallons of water. This must be done in a *wooden* vessel and it is best to tie the sulphate in a piece of sacking and suspend it in the water from a stick laid across the top of the vessel. The powdered sulphate dissolves very much more quickly than the large commercial crystals.

alone. If a four per cent. solution of copper sulphate is used, the cost works out at $6 per acre :—

	$ c.
4 men at 30 cents	1.20
150 gallons of 4 % copper sulphate ...	4.80
	$ 6.00

Mr. Whitfield Smith estimates that the cost of cleaning an acre of 300 trees by hand with brushes would amount to at least $12 for labour alone. In addition to this, there would be the cost of the brushes themselves, about $1. The difference therefore in favour of the copper sulphate treatment is $4.60 if a six per cent. solution is used, and $7 if a four per cent. solution is used.

It is proposed to continue these experiments during the present year and to determine whether this estimated cost agrees with the actual cost, and also to initiate experiments in which the yield of cacao on contiguous treated and untreated areas are compared for several years. In this way it will be possible to obtain economic results which cannot fail to be of interest to cacao planters in the West Indies, and it is also probable that by this or similar treatments the vertical range of cacao as a profitable cultivation may be extended, and plantations at high elevations which are now only giving moderate returns may be improved. Further it is proposed to try the effect of whitewashing the cacao stems as a preventive of the development of epiphytes on sprayed trees. At the same time it will also be possible to try to find out how copper sulphate kills these epiphytes and also to determine the best time of day to apply the solution. It is probable that this should either be applied in the early morning or else after rain, since the heat of the sun may cause the wash to dry up before it has done its work. In the experiments described above the wash was applied in the afternoon about four o'clock.

ROSIN COMPOUND AND OTHER WASHES.

It further seemed likely that these smaller epiphytes might be destroyed by spraying them with washes which have been found suitable against scale-insects. If these plants could be covered with some impervious varnish-like coating, it appeared likely that they would be destroyed very much after the fashion of scale-insects—by suffocation.

Accordingly trials were made at Dominica in August last with rosin compound* and whale oil soap on both lime and cacao trees. Whale oil soap was found to be useless but rosin

* The rosin compound was made by using 4lb. of powdered rosin, 3lb. of powdered washing soda and 1 gallon of water, boiling and when all is dissolved slowly making up to 5 gallons. This mixture was then boiled till it became of a clear brown colour and constituted the stock solution which was then made up to 15 gallons by the addition of water and applied with a knapsack sprayer.

compound gave very good results—indeed practically identical with those obtained with copper sulphate.

Mr. Jones visited the sprayed trees six weeks after the experiment and reported as follows:—

'There is no doubt as to the effectiveness of the rosin compound. Wherever this was applied the moss is dead and in no case is any injury apparent to the lime and cacao trees operated on.' (September 25, 1901).

These experiments were repeated in St. Lucia last August with varying strengths of rosin compound, viz., 1 gallon of the stock solution diluted with half a gallon, 1½ gallons, and 3 gallons of water, respectively. Mr. Moore, who visited the sprayed trees, reported that the stronger washes gave the best results. A favourable result was hardly expected on account of the heavy rains which fell a few hours after the washes were applied.

Cost of treatment.—The cost of treatment per acre with rosin compound of the strength used in the Dominica experiment is estimated as follows:—

	$ c.
4 men at 30 cents	1.20
150 gallons of rosin compound... ...	2.10
	$3.30

The cost of this wash is therefore much less than that of copper sulphate, and if the materials were imported direct from New York the cost would be still less. The above cost is calculated from local (Barbados) prices of rosin and washing soda.

It is hoped to continue these experiments with rosin compound during the present year and to test the effect of rosin wash, rosin and whale oil soap compound, and also sulphate of iron.

SUMMARY.

The subject dealt with in this paper may therefore be summed up as follows:—

(1) Epiphytes harm cacao and lime trees by blocking up the lenticels and interfering with respiration. Cacao trees are further harmed by this vegetation preventing the formation of pods.

(2) The larger epiphytes, like ferns, wild-pines and orchids, are probably best removed by hand.

(3) The smaller epiphytes are probably best removed by spraying with six per cent. copper sulphate or rosin compound.

(4) It is desirable to initiate experiments designed to find out:—

(*a*) the best time to apply the wash.
(*b*) the best strength of wash to use.
(*c*) the cost of treatment per acre.
(*d*) the increased yield of treated trees compared with contiguous untreated areas.
(*e*) the value of whitewashing cleaned cacao trees.
(*f*) the effect of other washes, such as rosin wash, rosin and whale oil soap compound, and sulphate of iron.

DISCUSSION

The Hon'ble WM. FAWCETT (Jamaica): A member of the Board of Agriculture of Jamaica, the Hon'ble T. H. Sharp, has lately brought to our notice various methods by which he hopes to obtain early crops of oranges. One method is to use a solution of carbolic acid as a wash on the trunks of the trees. Mr. Sharp applies the term 'stimulant' to this wash, but it appears to me that the effect is much the same as Mr. Howard wishes to produce, namely, the death of the epiphytic growths on the trunks, and the proper breathing of the trees. I hope Mr. Howard will continue his experiments and try the carbolic acid solution recommended by Mr. Sharp.

Mr. J. H. HART (Trinidad): I cannot follow Mr. Howard, at present, in his opinion that the presence of epiphytes has been proved to be pernicious. In my article on the subject recently published in Trinidad, * I stated that they should not appear on well cultivated estates, for if proper growth and cultivation are maintained, the trees shed the majority of these growths periodically. Again the amount of nitrogenous substance contained in the wild-pines (*Tillandsia* and other Bromeliads) may be a positive benefit to the trees. I am not, however, wedded to these opinions, and shall be only too glad to accept any conclusions which may be arrived at by the experiments now being carried on, in which I hope to join.

Dr. H. A. A. NICHOLLS (Dominica): I agree with Mr. Hart to a certain extent, but I do not go nearly so far as he does. When trees are affected with scale-insects the covering of the trunks by a light coating of lichen or moss is an advantage, inasmuch as scale cannot thrive under such vegetation. In the rainy season the scale-insects usually die and then the epiphytes being sodden with moisture can be easily removed, a piece of an old iron hoop and a cocoa-nut husk being all that is necessary in the way of appliances. It appears to me that the spraying of trees simply to kill the epiphytes is too troublesome and too expensive a method of treatment to be adopted generally. To allow trees to be clothed with heavy masses of epiphytic vegetation is contrary to all rules of cultivation; and a careless planter who permits such a thing will certainly not employ the spraying machine. It would be difficult, if not impossible, to spray effectually trees on steep hill-sides; and sometimes, very steep places in Dominica are planted with cacao and lime trees.

Mr. G. WHITFIELD SMITH (Travelling Superintendent of the Imperial Department of Agriculture): In the mountain lands of Grenada cacao trees are often covered by epiphytic plants and mosses. It has been found that the removal of these is absolutely essential to the healthy growth of the trees. For this purpose wire brushes, cocoa-nut husks and blunt knives made of bamboo are used. The husks in the hands of careless workmen often injure the bark and flower-buds of the trees. In any case cleaning cacao trees by hand is tedious and ex-

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**Trinidad Bulletin*, Vol. IV, p. 393, October 1901.

pensive work, often costing as much as $10.00 per acre. Any method of eradicating these epiphytic growths at less expense would be greatly appreciated by cacao planters in these islands.

Mr. W. E. BROADWAY (Grenada): I am of opinion that the removal of these growths from the trunks and branches is necessary and that if this is not done, in the case of cacao trees in Grenada, comparatively small crops result.

Mr. H. POWELL (St. Vincent): I can bear out what Mr. Whitfield Smith and Mr. Broadway have said as to the absolute necessity of cleaning cacao trees of lichens, wild-pines, etc. I know of some old plantations where the trees were covered by epiphytes, the latter were cleared away and the following year the crop was about doubled. The cleaning was effected by means of brushes and hand-picking, and great care was taken not to injure the flower-buds.

Mr. HOWARD: With regard to the criticisms of Dr. Nicholls, experiments were made in Dominica, and I am sure it would have been impossible for children to clean the lime and cacao trees on which the experiments were performed. They could not reach, and if they climbed into the trees they would do more damage than good. I am of opinion that hand-cleaning is impracticable and that spraying gives better results. Hand-cleaning is not reliable because small portions of the epiphytic growths are left upon the trees and grow again, whereas spraying kills everything. In reply to Mr. Fawcett, carbolic acid solution has not been experimented with, but I hope to do so to test its value in the future. I agree with Mr. Hart that it will be best to carry on experiments and let the results of those experiments supply an answer to the question.

The PRESIDENT: We have had an interesting discussion on the subject of foreign growths on cultivated trees. It has always been understood by those who have had long experience in the cultivation of cacao and other trees that the presence of lichen, moss, ferns and 'wild-pines' upon them is injurious and that if the trees are allowed to be over-run by them their productiveness is affected. Nothing advanced by Mr. Hart justifies us in regarding such growths as otherwise than unsightly and detrimental to the trees, specially those cultivated for crop purposes. One can readily understand that in a Botanic Garden a tree here and there might be allowed to be covered with epiphytes and parasites to illustrate the arboreal habit acquired by certain plants; but this is a purely scientific experiment and does not affect the main question at issue. With regard to the statement that, if proper growth and cultivation are maintained, cacao and other trees would shed the majority of epiphytic growths 'periodically,' this could be easily settled by observation and I would be glad if the subject could come up for discussion at the next or following Conference.

RAW SUGARS FOR BREWING PURPOSES.

BY THE HON'BLE FRANCIS WATTS, B.Sc., F.I.C., F.C.S.

Government Analytical and Agricultural Chemist for the Leeward Islands.

The following paper was read before the Agricultural and Commercial Society of Antigua, on June 6, 1902:—

Of recent years there has grown up an enormous industry directed to the manufacture of sugar for brewing purposes. The requirements of this trade differ greatly from the requirements of the refining industry, hence sugars, which from the refiner's point of view, are of low grade, may be suitable and satisfactory when judged by the standard of the manufacturer of brewing sugars.

PRESENT SOURCES OF BREWING SUGARS.

A very large proportion of the brewing sugar used in Europe and America is made from starch by boiling it with sulphuric acid, removing the sulphuric acid by means of lime, —the two combining to form insoluble sulphate of lime, which is removed from the sugar solution by filtration, after which the solution is concentrated in vacuum pans and produces commercial glucose, of which enormous quantities are consumed.

Any cheap form of starch may find an application in this industry, the chief sources being sago meal of Borneo and the East, maize, cassava starch, and potatos. The prices paid for these meals and starches are very low and are such as have, so far, led to no attempt on the part of the West Indies to compete for any of this trade. I am not informed as to the exact prices of these articles to-day, but I suppose sago meal can be purchased in London at about £6 or £7 a ton.

A very considerable quantity of brewing sugar is also made from cane sugar, and it has been suggested from time to time that West Indian cane sugar may find a market in this direction. At present the cane sugar used in London for this

purpose is the low-grade cane sugar from Madras, the Philippines and other eastern countries.

If we are to enter into this trade we must remove from our minds all the old standards of quality arising from the requirements of the refiner. The refiner desires cane sugar as pure as possible, of good colour and free from any notable quantity of glucose. The actual working standards, however, are influenced by other trade conditions, notably by the protective tariff of the United States, where sugar for refining must be below a certain colour standard, not that this is desired from the refining point of view but is designed to protect the refiner from competition. Under other conditions high-grade raw sugar might be used for consumption without previous refining, to the detriment of the refiner's interest. Roughly speaking, the refiner wants cane sugar as pure as he can get it.

THE BREWER'S REQUIREMENTS.

Now, for the brewer, glucose has an equal value with cane sugar,—it has just been said that an immense business is done in starch glucose,—so the manufacturer of brewing sugar is prepared to buy sugar in any form, as cane sugar, as glucose, or in the potential form as starch. His requirements are, absence of dirt in the form of earthy matter or non-fermentable matters, absence of unpleasant colouring matters such as may arise from overheating the sugar in the course of manufacture, and absence of unpleasant flavouring matters such as exist to a marked extent in unrefined beet sugar. Hence when the manufacturer of brewing sugar desires to employ sugar products in his industry, he is limited to *cane* sugar, that is, the product of the sugar-cane, or to refined beet-root sugar, raw beet sugar being unsuitable. This fact constitutes a strong point in our favour should we desire to enter into this trade.

As the manufacturer of brewing sugar will buy glucose on the same terms as cane sugar, whereas the refiner attaches a heavy penalty to its presence, it follows that for low-grade sugars the former industry offers the better outlet: but these low-grade sugars are the result of accident or disaster, and it does not seem possible to effect a separation in our sugars whereby we may send the high-grade sugars to the refiner and the low-grade sugar to the brewing sugar maker, though this perhaps may receive consideration at your hands.

POSSIBLE TRADE IN MOLASSES.

Now good, sound, muscovado molasses, containing as it does about 53 to 55 per cent. of cane sugar, 12 to 14 per cent. of glucose, and 18 to 20 per cent. of water, and having nothing objectionable in the way of colour or flavour will be readily accepted by the industry we are considering, but at a low price, for it must compete with cheap starch.

Molasses in itself is cheap enough, but unfortunately, being fluid, it requires expensive packages for its transport. If some means can be devised for reducing the cost of packages, then I

feel sure that molasses may find a more profitable outlet in this direction than is at present open to it. It is therefore desirable that efforts should be made to ascertain whether by providing cheaper packages, or by securing the return of the packages that they may be used over and over again, or by shipping in tanks, this trade may be secured to these islands.

It is important to remember that the trade is a very large one, so that if anything at all can be done in it, it will be easy to dispose of the whole of the molasses and to make contracts beforehand, if desired. I have some fear that, the trade being so large, our efforts and our supplies may appear too small to be worth serious attention. However, the magnitude of the trade should enable us to secure all the advantages to be derived from cheap freights, while it will admit of ships being quickly loaded with full cargoes, and this may have an important bearing in the matter of tank steamers. The annual output of molasses in the Leeward Islands must be over one and a half million gallons. This ought to be sufficient to form the basis of satisfactory trading and transport relationships. Everything depends upon cheap packages and cheap freight, which themselves depend upon a definite and well-organized trade. It seems to me that we have here the opportunity to put our molasses industry on a sound and satisfactory footing and that nothing is required but mercantile push and energy.

I made inquiries concerning this trade when last in London and submitted analyses of Antigua molasses to important merchants. The result was to elicit the fact that Antigua molasses is suitable for the purpose in view and that at that time (August 1901) the value was about £4 10*s*. 0*d*. to £4 15*s*. 0*d*. per ton c. i. f. Now a gallon of molasses will weigh about 13½ lb. A ton will thus be about 165½ gallons: or, taking puncheons as holding 90 gallons, 100 tons will be equal to 184 puncheons.

If we examine these figures it will be seen that there is some margin for business when the local price of molasses is very low, in other words, when the local price of molasses is what it is to-day. I cannot help thinking it would be an advantage if planters could dispose of every gallon of molasses they make, and as fast as they make it, instead of trusting to the uncertain market now open to them.

During my interviews I gathered that the buyers would be willing to return the packages, knocked down in shooks, at a very low rate, probably as low as 1*s*. 3*d*. per package. This seems to me one of the most important points of the whole scheme.

Even at the low prices offered I see no reason why molasses should not realize over 2½*d*. per gallon in Antigua, exclusive of the cost of packages, and I believe large contracts could be made.

SUGGESTED EXPORT OF MASSE-CUITE.

But another point remains. If, instead of making musco-

vado sugar, we send the undrained *masse-cuite* in the form of concrete, we shall provide an article quite acceptable to the manufacturer of brewing sugar. As you are aware, some attention has been given to this question; samples have been prepared and have been valued. I myself have had interviews with the people most interested in this trade and may briefly sum up the position and their requirements thus.

The buyers require material containing either cane sugar or glucose, or both, in a clean condition, free from unnecessary dirt or impurities, of fair colour, not burned or scorched. For their purpose it is not very material whether the substance is solid, pasty or fluid. It will be valued on the basis of the quantity of total sugar (cane sugar and glucose) which it contains, or practically, on the basis of the proportion of solid matter. In July 1901, the following trade basis was suggested: 8*s.* 5*d.* per hundredweight for concrete containing 85 per cent. of total sugars (or of total solids), with an addition of 1½*d.* per hundredweight for each 1 per cent. of sugars above 85 per cent. ex ship in London. Thus on those terms the value of a hundredweight of concrete containing 90 per cent. of sugars would be 9*s.* 0½*d.* (8*s.* 5*d.* plus 7½*d.*) There should, I think, be no difficulty in making concrete containing 90 to 93 per cent. of total solids.

Now, although it is a matter of little moment to the manufacturer of brewing sugars whether he receives his raw material in the form of a solid, a paste, or a fluid, it is a matter of the greatest moment to the shipper, for upon its condition depends the nature of the package required. If a solid can be produced, the question of packages is reduced to its simplest form, for the material may be shipped in bags; if paste or fluid, wooden packages, more or less costly, will be required.

In order to make comparisons between the value of concrete and of muscovado sugar with its accompanying molasses, it is necessary to ascertain the relative weights and values of the articles under discussion. If we assume that 60 gallons of molasses are produced for every ton of sugar, we can take the weight of the molasses and sugar together as 3,050℔. (60 multiplied by 13½, plus 2,240℔.) Allowing for higher concentration for the production of concrete we must deduct about 6 per cent., or 180℔. We have, then, 2,870℔. of concrete or 1·28 tons as the equivalent of one ton of muscovado sugar and 60 gallons of molasses.

ESTIMATED ESTATE RETURNS.

We can apply this for the following calculations. An estate now making 100 tons of muscovado sugar and 6,000 gallons of molasses would, under the new system we are considering make 128 tons of concrete of about 90 per cent. This concrete on the prices just mentioned would be worth £9 per ton in London, thus yielding a gross return of £1,152. Now the value of 100 tons of muscovado sugar, testing 89° at $1.80 per 100℔ in Antigua, the price when the above quotations were made, is £840, while the molasses (at 2½*d.* per gallon) is worth £62. Whence the value of the sugar and molasses together is £902

in Antigua, exclusive of the cost and value of molasses packages. There is thus a difference of £250 between the gross amounts received for concrete in London and for sugar and molasses in Antigua. In other words, this sum of £250 is the amount out of which provision is to be made for delivering the concrete in London, together with any additional expenses in the way of packages beyond the bags required to pack 100 tons of sugar.

We thus arrive at the conclusion that we have practically £2 per ton to provide freight and extra packages should these be necessary, in order to place concrete on the same monetary footing as muscovado sugar with its molasses. It is at once evident that this sum will not admit of the provision of expensive packages, and brings us back to the original position, namely, that this trade depends entirely upon cheap packages. It would be advantageous for planters to ascertain for themselves, by means of a few experiments, whether they can produce concrete sufficiently solid to permit of shipment in bags.

In connexion with the foregoing calculations one fact should be stated. The average quality of Antigua muscovado sugar is probably somewhat under 89° in test. Owing to the deduction which is made for anything testing below 89°, it follows that there is a gain of about 6*s.* per ton in favour of concrete when contrasted with muscovado sugar for each degree below 89° on the part of the sugar. If, then, any planter finds his average test to be about 87°, he can add 12*s.* per ton in favour of concrete to the figure arrived at in the previous calculation.

A few experiments will soon demonstrate whether concrete can be satisfactorily made in the existing steam pans. I see no reason why experimental quantities, at least, should not be made without any alteration in existing machinery.

In conclusion I would urge upon planters the desirability of keeping themselves informed of the possibilities of these markets for molasses and concrete in order that they may take advantage of them in the event of the ordinary markets for muscovado sugar being closed through the changes which will follow the abolition of the European sugar bounties.

STOCK REARING IN JAMAICA.

The Hon'ble P. C. Cork, formerly of Jamaica, and now Colonial Secretary of British Honduras, writes:—

Observing from recent publications of the Imperial Department of Agriculture that the question of the care of pastures and the treatment of screw worm in stock is engaging attention, it has occurred to me that a short account of an actual experience of mine in stock-rearing in Jamaica may be of interest. A few years ago a connexion of mine who was unable to attend to it himself owned a cattle farm of about 1,400 acres, 500 acres of which were in guinea grass, about 400 or 500 in wood with

little feeding for stock, and the remainder in good common.

TREATMENT FOR TICKS.

There had been a plague of ticks and many cattle had died of tick fever, reducing the herd to 250. Only twenty-five calves had been reared the previous year. This 'Pen' came under my control, and I set about inquiring into the causes of the wastage of stock that had occurred, and found that in addition to the tick fever, the great mortality had been caused by screw worm, and by failure in milk production of a good many cows. I suffered under the great disadvantage of only being able to devote an occasional week end to personal supervision, but after long application to desk work for several days, it was a great relief to mount a horse and ride through the pastures, examine the statistics, and inspect the herds, analysing everything as best I could so as to trace back results to their true cause and devise a speedy and economical remedy for defects. Change of occupation is most restful and I experienced its benefits. For the tick fever I used kerosene oil emulsion (being the cheapest preparation I could discover), and the pen men added green tobacco leaves pounded so as to get out the juice, applied with whitewash brushes. This mixture, applied whenever an animal came into the pen with ticks soon gave the stock shining clean coats.

SCREW WORM.

For the screw worm nothing was used but Jeyes' fluid applied with a small brush which could be got within the orifice of any sore. A regular system for everything had however to be enforced. All saleable cattle were gradually got rid of and the money used to purchase heifers and bulls; every cow's udder was carefully examined and those which had got injured detected, the cows being fattened for the butcher instead of being permitted to breed. A pasture near the dwelling house was set aside as a 'dropping pasture' or lying-in hospital, and another as a paddock for the sick. The animals in these pastures had to be attended to every morning. Any calf born since the previous morning was dressed with Jeyes' to prevent flies from coming near their navel, and the mother's udder had to be tested to see that the milk flowed freely, and this process was repeated every two or three days until all danger of attack from the screw worm had passed and the calf was feeding heartily. This work hardly ever occupied more than an hour of the time of a man and a boy, and after that one of the herds such as the breeding cows, the young heifers, or the young steers, would be driven in and carefully examined (each herd once a week). Any cow observed to be near the time for calving would be separated and put into the dropping pasture, and any animal showing cuts, bruises, etc., dressed with a strong solution of blue vitriol, or if screw worm had made its appearance the worm was killed with Jeyes' fluid, the wound washed with soap and water and a second application of the fluid made before the animal was allowed to leave the pen.

SUCCESSFUL RESULTS OF TREATMENT.

In the first complete year after this system had been got into thorough working order, ninety-seven calves were born, one of which died from a lightning stroke, one from cramp, having been born in the midst of a torrential downpour of rain while the overseer was absent from the property, and one from insufficient nourishment, its mother being one of those with a damaged udder which had been weeded out of the breeding herd but had jumped the stone wall and taken the bull before it was discovered. Ninety-four of these calves lived, and, had the overseer been present at the time, the one which died of cramp should have been saved by the application of warmth; while that which died of insufficient nourishment should have been separated from its mother and given into the care of a cow having sufficient milk to rear two calves. I was, however, not aware that this calf was being neglected. The stock on the 'pen' were speedily increased to 450 in number.

The moral of this tale is, that it does not require any very scientific treatment to circumvent the screw worm or the tick, but a good system thoroughly carried out is essential, and when once established it is surprising how much labour and trouble it saves the herdsmen who find their sick cattle reduced to a minimum, no sores on their calves, and the udders of their cows yielding milk freely.

IMPROVEMENT OF PASTURE LAND.

As regards the improvement of pasture land, the least expensive method I know of is to take up a portion periodically, and cultivate it for two or three years in such crops as are suitable to the soil and situation. In most places in the West Indies, maize, millet, peas, potatos or cassava may be profitably grown, or at any rate may be expected to yield enough to pay for thoroughly breaking up the land and planting it out in guinea, para, or other grasses after the crops have been reaped. The soil being loose the grasses will root well and flourish for years without further cultivation, and the fodder will be sweet and succulent. Pastures should be well fenced, fed out systematically and then rested until the grass is well grown, and water should be available in each pasture so that the stock may drink whenever they feel inclined to do so. A few large shade trees are also necessary for cattle to shelter themselves from the sun. In places where milk production is a consideration, or where there are periodic droughts, the produce of the cultivated land should be fed to the stock to increase the milk supply or to tide the stock over the dry season without loss of condition. For shade in pasture land no tree can be better than the guango (*Pithecolobium Saman*) on account of the valuable feeding qualities of the pods which it bears.

The cattle farmer has to recollect that, as the strength of a chain is its weakest link, so the value of his pastures for grazing depends on the amount of food available for his cattle at the driest season of the year, and his farm should

only be stocked up to the limit of the food and water supply at this season: if overstocking takes place many deaths occur, primarily from want of food, the stock being unable with their enfeebled constitutions to withstand the attacks of the screw worm, ticks, or any disease which may appear amongst them. The selection of breeding stock also has much to do with successful cattle farming. The Shorthorn requires a great deal of coddling and very frequently shows symptoms of scrofula. The Hereford is more hardy but lacks fecundity. A very successful type of bull I found to be a cross between the Mysore and Hereford, the combination giving strength of constitution without loss of size, and supplying the fecundity which is lacking in the Hereford. I throw it out as a suggestion that the Mysore is the product of a tropical, and the Hereford of a temperate climate: the former is easily acclimatized in the West Indies while the latter requires time to become accustomed to the altered conditions.

MANURING AND STORAGE OF SWEET POTATOS.

In the *West Indian Bulletin*, Volume II, pp. 293-302, an account was given of 'Recent Experiments with Sweet Potatos' in the West Indies.

The article contained a short description of the trials being conducted with different varieties of sweet potatos, in Antigua and Barbados. These trials have been continued this season and additional plots have been started in some of the other islands. The main portion of the article was devoted to an account of the efforts made by Dr. Numa Rat in Anguilla, and Mr. Spooner in Antigua, to prepare a sweet potato meal at remunerative rates. Their work demonstrated that it was possible to manufacture a meal which is palatable, digestible and cheap. This meal, if carefully prepared, can be kept for a considerable period without deteriorating and affords a practical means of preserving sweet potatos for some months after they are dug.

On page 296 of the article in question we quoted Professor J. F. Duggar of Alabama to the effect that: 'There is need for further investigation to determine the best method of storing sweet potatos, for the losses occurring during storage are sometimes enormous.' On this important point Mr. F. S. Shiver contributes to Bulletin No. 63 of the South Carolina Experiment Station an account of the results of experiments on the manuring and storage of the sweet potato. The following comprehensive summary of his researches is taken from the *Experiment Station Record* of the United States Department of Agriculture, Vol. xiii, pp. 446—8, and contains much matter of immediate interest to planters in the West Indies.

It must be remembered, as previously pointed out, that the conditions in the States are very different from those obtaining in the West Indies, and planters would be well

advised in putting the results as to storage here set forth to a practical test under West Indian conditions.:—

This bulletin sets forth the results of three different lines of observations, namely, the effect of fertilizing with different forms of potash on the starch content of the sweet potato, the effect of storing upon the composition, and the relative value of several generally used methods of storing. The results with different forms of potash as a fertilizer are presented in the following table:—

Results of experiments with different forms of potash as a fertilizer for sweet potatos.

Fertilizer.	Original material.		Water-free material.		Yield of sweet potato per acre.	Yield of starch per acre.
	Water.	Starch.	Dry substance.	Starch.		
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Pounds.*	*Pounds.*
Compost and kainit ...	63·81	22·86	36·19	63·16	11,403	2,607
Compost and muriate of potash ...	63·77	22·21	36·23	61·31	9,006	2,000
Nothing ...	62·07	24·58	37·93	64·80	7,986	1,963
Compost and sulphate of potash ...	64·97	21·63	35·03	61·75	9,576	2,071
Compost and silicate of potash ...	65·87	20·70	34·13	60·66	9,744	2,017
Compost ...	65·26	20·80	34·74	59·88	8,103	1,685

Compost was used at the rate of 1,000 ℔ per acre, while kainit, muriate, sulphate, and silicate of potash, were applied at the rate of 400, 100, 100, and 250℔ per acre, respectively. The variety used in this test was Horton yam.

The study of the effects of storing on the composition of the sweet potato was conducted with the same variety. The sweet potatos fertilized with the different forms of potash mentioned above were stored November 28 and analysed at that time and at different periods later.

The figures for all plots for the different periods are given in the following table :—

Analyses, at different periods of storing, of sweet potatos fertilized with different forms of potash.

Fertilizer applied.	November 28, 1898.				March 1, 1899.				April 17, 1899.			
	Water.	Starch.	Glucose.	Sucrose.	Water.	Starch.	Glucose.	Sucrose.	Water.	Starch.	Glucose.	Sucrose.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Kainit ...	63·81	22·86	0·96	5·41	65·04	18·71	1·20	6·18	67·11	15·84	0·36	7·10
Muriate of potash	63·77	22·21	1·20	6·10	63·81	18·42	1·23	7·35	66·84	14·58	·90	7·46
Nothing ...	62·07	24·58	1·19	5·28	67·77	17·74	·59	6·26	63·78	16·69	·59	9·51
Sulphate of potash	64·97	21·63	1·51	5·59	62·31	20·07	·89	8·05	66·61	18·43	·90	6·57
Silicate of potash	65·87	20·70	1·27	6·03	75·05	11·84	1·63	4·90	(a)	(a)	(a)	(a)
Compost ...	65·26	20·80	1·41	6·21	67·02	14·83	1·11	8·97	(a)	(a)	(a)	(a)

(a) Tubers spoiled.

After a storage of 140 days, the roots fertilized with kainit had lost 30·7 per cent. of the starch originally present; those fertilized with muriate of potash, 34·4 per cent.; the roots which had received no fertilizer, 32·1 per cent.; and those fertil-

ized with sulphate of potash, 14·8 per cent. The sweet potatos from the other plots decayed.

Analyses of several varieties of sweet potatos stored for different lengths of time.

Date of analysis.	Pumpkin Yam.			Bunch Yam.			Georgia Sugar Yam.			Tennessee Yam.		
	Starch.	Glucose.	Sucrose.	Starch.	Glucose.	Sucrose.	Starch.	Glucose.	Sucrose.	Starch.	Glucose.	Sucrose.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Nov. 14, 1899...	17·38	1·08	5·17	13·92	1·38	5·47	18·41	1·08	5·08	15·74	1·41	5·02
Dec. 14, 1899...	14·57	1·12	5·93	9·61	·78	4·17	16·83	1·24	5·07	14·71	1·11	5·67
Jan. 15, 1900...	10·05	2·59	8·83	12·30	1·73	8·61	14·98	1·73	8·14	14·74	1·84	7·37
Feb. 15, 1900...	10·08	1·45	7·12	8·18	1·64	9·48	13·76	1·45	8·78	13·25	1·18	9·05
Mar. 15, 1900...	11·12	1·04	11·59	8·83	1·68	11·70	13·42	1·10	11·96	9·94	1·15	9·75

It would appear from these particular experiments that the loss of starch, which the sweet potato sustains on storing, is to be attributed very largely, but not wholly, to the increased formation of sucrose or cane sugar in the same. There may be possibly formed some other intermediate products such as dextrin, but this has not yet been established.

Analyses of sweet potatos stored by different methods.

Method of storing.	January 7, 1899.				March 1, 1899.			
	Water.	Starch.	Glucose.	Sucrose.	Water.	Starch.	Glucose.	Sucrose.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
In straw, covered house	73·59	7·20	3·46	7·51	...	...	...	...
In sand, covered house...	74·32	11·59	1·23	6·71	73·97	9·07	1·33	7·98
In cotton-seed hulls, covered house ...	72·81	12·99	1·41	6·02	71·26	15·82	·68	5·12
In cotton seed, covered house ...	71·46	11·86	2·30	6·59	69·68	15·68	·55	6·04
In usual way (straw, cornstalks, etc.) ...	69·52	13·51	1·74	7·66	75·80	9·88	3·21	3·77

In connexion with this work, the effect of storing upon the composition of different varieties of sweet potatos was studied. The highest content of starch, 19·58 per cent., was found in the Bunch yam, and the next highest in the Georgia yam. It was noticed that a high percentage of starch was usually accompanied by a low percentage of sucrose and that the glucose content of sweet potatos is not subject to great variations. These roots were stored November 28, and an analysis made January 7 showed an average decrease of about 19·8 per cent. of the starch originally present. This rapid loss of starch is attributed to storing the roots in a damp condition. The sucrose content showed an increase from 4·95 to 8·87 per cent. for the same period of time. The Hanover yam preserved its starch content better than any other variety, being followed closely by the Georgia Buck varieties.

During the author's absence this work was continued by C. C. McDonell, with 4 varieties: the Pumpkin yam, Bunch yam, Georgia sugar yam, and Tennessee yam. The results of analyses made on different dates are given above on page 209.

The average content of starch decreased from 16·27 per cent. to 10·92 per cent. during storing, while the average percentage of sucrose increased from 5·21 to 11·31 during the same period of time. It was further observed in these different experiments, that the sweet potato loses very little water while in storage. The results of work along this same line conducted at the Texas Station and previously reported (*Experiment Station Record*, VII, p. 684) are reproduced for comparison.

For the purpose of determining the relative value of different methods of storing, roots of the Georgia Buck variety were stored in a covered building, in straw, sand, cotton-seed hulls and cotton seed, and in the ordinary way in piles covered with straw, cornstalks, dirt, and a shelter of boards. According to an analysis of a large composite sample, the roots on November 28, before storing, contained 75·35 per cent. of water, 13·13 .per cent. of starch, 0·77 per cent. of glucose, and 4·31 per cent. of sucrose. The results of analysis after storing are given on page 210.

The method of storing largely influenced the changes in composition. The best results were obtained with the use of cotton-seed hulls, dry sand, and cotton seed, in the order named. Storing in straw is not considered advisable.

OBJECT LESSONS AND SCHOOL GARDENS.

In the schemes for Agricultural Education in various parts of the world, 'School gardens' and instruction by 'Object lessons' are assigned a prominent position. The latter serve to bring the children into close contact with common natural objects, and to develop their powers of observation. The school garden affords a wider field for object lessons, in addition to providing the pupils with the opportunity of learning *practically*, at first hand, some of the principles underlying agricultural practice. In the *West Indian Bulletin*, Vol. I., pp. 428-44, were reproduced two circulars issued by the Board of Education of England in 1895 and 1900 with the view of 'encouraging the children to gain an intelligent knowledge of the things that surround them in the country,' and giving general direction for object lessons. This article was followed in the same Volume (pp. 444-57) by an abstract of an important memorandum issued by the French Minister of Education, relative to Agricultural Education in French Schools. The Imperial Department of Agriculture has given courses of instruction to teachers, accompanied by practical work, throughout the West Indies, and, in addition, has issued *Nature Teaching*, a text-book prepared by Mr. Francis Watts and others,

containing a detailed course of agricultural teaching especially adapted for use in West Indian schools. Full instructions for the arrangement and management of school gardens have also been given in No. 11 of the Department Pamphlet Series, *Hints for School Gardens*, by Mr. W. G. Freeman. School gardens and school plots are now a recognized feature in many of the West Indian Islands.

To the managers and teachers of many West Indian schools, the reprint of two pamphlets recently issued by the English Board of Education, showing some of the courses of instruction in actual operation in English schools should be of interest.* In order to make these of greater value to the West Indies, notes are added (in italics, enclosed in square brackets) containing suggestions as to local objects which may be employed in the lessons in place of those mentioned which are not obtainable in the West Indies :—

THE AIM OF THE SCHEMES.

The following outline schemes of instruction afford examples of the attempts which are actually being made to adapt the teaching in country schools to country life. They are published as being tentative and suggestive rather than complete or perfect models. The Board of Education, in calling attention to what has been already attempted in certain schools, hope to encourage similar efforts in all parts of the country.

The perusal of the schemes will show that while having a common aim, the teachers have found scope for great variety in the methods of reaching it. The value of this kind of teaching is diminished if local circumstances are disregarded, and it will be well if teachers devise similar or improved schemes for themselves, instead of adopting any one of these without modification.

The aim is that children who live in the country should, when they leave school, find themselves in sympathy with their surroundings, and should be able to take an intelligent interest in the pursuits and occupations which are open to those whose lives and homes are in the country.

It is important however to notice that education of this kind, while suitable for country children, is of equal value to those whom necessity may require to spend much of their future lives in towns or large centres of industry.

The object lessons should be continued throughout the elementary school life of the child. The nature of the lessons should, however, vary with the progress of the child, and may usefully become more special in character during the later years of school life.

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* *Specimen courses of Object Lessons of common things connected with rural life and industries, for all classes in rural schools, 1901.*

* *Specimen Courses of Object Lessons and Instruction in Gardening in actual operation in Elementary Schools, 1902.*

WHAT MUST BE AVOIDED.

In arranging plans of instruction for rural schools, it is important at the outset to emphasize what should be avoided. *It is not desirable to attempt a definite course of instruction in the principles of agriculture, or to teach the art of farming.* The aim of primary education being general and not professional, it is as undesirable as it is impossible to attempt to provide a special form of training in primary schools.

It is, therefore, not recommended that the studies of the children should be confined to those specimens of the animal and vegetable kingdoms with which they will have to occupy themselves in the way of business later on in life. The lessons should not be concerned solely or mainly with cows, horses, wheat, and potatos, nor with plants and animals which are usually found on a farm, but besides these they should deal with common objects of the country in general.

Similarly, it is not worth while to devote any of the children's time to reading about ploughs, reapers, separators, and the like. Simple lessons in 'the mechanics of everyday life' are of more permanent value for educational purposes than lessons about the latest agricultural machinery. Occasional expeditions, however, to watch such machines at work will serve to make calculations at the school desk more interesting and practical, and rough drawings of agricultural implements, or parts of them may often be made with advantage.

Again, what it is most important to teach children is not the names of the best varieties of particular crops, but by outdoor observation what is meant by a variety of a plant, and how this knowledge may be turned to practical account. Studies of a general character should precede specific studies, and object lessons in the elementary school are the best foundation for systematic studies in science at a later stage.

OBJECT TEACHING NOT THE SAME AS TEACHING A SPECIFIC SCIENCE.

Object lessons in country schools should tend to produce a taste for work and study out of doors. The aim of a specific science is the search after a logical connexion between observed facts and their classification or the establishment of laws of nature. The purpose of the object lesson is rather to set children to ask themselves questions in regard to surrounding objects, such as 'What does this mean and how does it act and why?'

THE GROUPING OF OBJECT LESSONS.

Object lessons, however, although not continuous in the sense of forming a systematic study of a particular science, should be classified into convenient groups. The selection of objects for study should be made with a purpose. A miscellaneous list of lessons which is not carefully thought out and designed to produce some definite result is as undesirable as a course in a specific science.

Nature studies should direct the children's attention to natural objects which are to be met with in their own neighbourhood, and they should be varied and not confined to one class. For example, it is not desirable that the children should only learn about flowers and insects and learn nothing about the common phenomena of nature; nor again, that the object lessons should deal with the elements of chemistry or physics or mechanics to the exclusion of the study of living nature such as plants, insects, and birds.

In a good object lesson the object is approached from many points of view, and all knowledge that bears on the object has its place. The same object when dealt with as part of a science course is only or mainly considered in its connexion with that particular science, and, in consequence, becomes much less rich in general significance. The mental development of children in primary schools has not reached the stage when specific study of a particular science is profitable.

OBJECT TEACHING AND PRACTICAL INSTRUCTION.

By Object Teaching the hand and eye ought to be trained to assist the development of a child's thinking powers. A child who has seen with his eyes and illustrated by use of his hand, partly by preserving in a collection, partly by modelling in clay, and partly by drawing, some of the objects which are described in the numerous books on Nature Study will possess the power of observing and comparing and distinguishing and classifying and adapting the results of all these processes to some practical purpose. Such results are of use in all walks of life. They are essential to the enjoyment of country life.

All good Object Teaching should give the scholars something to do with their hands. The oral lesson by itself is very inadequate. The oral lesson which is accompanied by demonstration is an improvement upon one which is without this illustration, but to make the instruction really complete, the scholar must make and record observations, collect specimens, make rough drawings and plans, and perform experiments for himself, and thus take an active share in his own instruction and learn to teach himself under guidance. School expeditions are a useful part of this kind of teaching.

In every country school it is quite possible that a rough map may be constructed and hung up, showing, with the school as a centre, the places within easy distance where various natural objects may be seen and studied.

THE SUBJECT-MATTER.

The subjects that are of special interest to children living in the country are set forth under the following heads, which contain none that cannot be studied through lessons in which the objects which are chosen for illustration may be actually seen, watched, or handled, or, in some cases measured:—

1. Birds and their habits.
2. Insects. The life history of a few common insects

3. Flowers. The growth and habits of some wild and garden flowers.

4. Trees and the common kinds of timber.

5. Ponds and streams. Living things in still and running water. Sand and mud. Pure and impure water.

6. Soils, mud, sand, clay, gravel, etc. Observation of quarries and lime pits.

7. Air. Weather chart. Rainfall. Frost and heat. Ventilation.

8. Breathing. Digestion. The Heart and Blood.

9. Physics in every-day life. (Clothing and warming.)

10. Chemistry in every-day life. (Food of man, beast and plant.)

11. Mechanics in every-day life. (Levers and pulleys.)

12. Natural History Calendars.

13. Outdoor studies in Geography. Land measuring.

Of course no school will attempt all the subjects which are here suggested. Various groups of Object Lessons will be arranged for various schools according to the tastes, acquirements and opportunities of the teachers.

CONNEXION WITH OTHER STUDIES.

It will be apparent that studies of the above kind are not to be regarded as separate subjects which can be dealt with independently of the rest of the work of the school. They cannot be set down on the time-table under one specific head. The Reading lesson, for example, may treat of an object which has been dealt with at another time by direct observation or experiment. The art of describing what has been seen or handled will be practised in the lessons on English Composition. Measurements of land and similar calculations in connexion with the Object Lessons will afford practice in Arithmetic, while Drawing and Manual Training will both be called into play to illustrate many details which are inadequately understood without their aid. The general instruction of the school will be modified in many of its branches by the study of the world of nature outside.

Consequently, work of this kind is not of the nature of an additional study (as it is, for instance, in the case of commencing a foreign language) but rather a change in the contents of the lessons in the ordinary subjects, and the Board of Education are aware that this change can only be made gradually.

GARDENS.

It will be noticed that many of the appended schemes show the great use made of gardens by teachers, not only for actual work, but also for purposes of illustration. For these purposes gardens are of the greatest value.

The objection, however, is sometimes raised, that, single-handed, a teacher in a country school cannot attend to the younger

children in school while he or she superintends the instruction of the older ones in the garden.

The difficulty is an obvious one, but it may be overcome if the outdoor lessons are short ones, and if at this time the younger children are left in the care of a monitor to do some simple work that does not require the immediate supervision of the teacher.

But a more satisfactory method of overcoming the difficulty would be by engaging the services of a competent person in the village to give the practical instruction out of doors. For this no certificate or diploma is required. By the co-operation of several schools it may be possible to engage a peripatetic teacher to visit each of them in turn. This arrangement might be much facilitated by having a continuation gardening class under the County Council in each village, the instructor of which would probably take the day school class at a less salary than if he were specially engaged for the purpose by the managers of the day school.

Particular attention is drawn to the great assistance, in the promotion of all forms of practical instruction, which the combination of a few adjacent parishes affords.

Where it is not easy to obtain land for the gardening class, the instruction is occasionally given in the garden of one of the local landowners.

HINTS TO TEACHERS.

1. Do not attempt too much in one lesson. One object may usefully supply matter for several lessons, each beginning with a little recapitulation of what has been found out before.

2. Secure a succession of suitable objects.

3. In every expedition take care that the class know before-hand what they are going to see, and that they afterwards make some written or drawn reproduction of what they have seen.

4. The instruction given should be based upon observation and experiment. It is very important that lessons should not be given upon subjects which cannot be seen by the children or demonstrated to them.

5. Encourage the children to draw the various objects and apparatus shown, and especially such things as the various stages in the development of the tadpole from the egg, the germination of seeds, the structure of flowers, etc.

6. In some cases the children may be encouraged to make simple models of objects which they have seen and examined, but in no case should the model replace the actual object.

7. The children should be called upon in turn to assist the teacher in preparing apparatus for experiments.

8. The instruction should in every case be appropriate to the season of the year and the circumstances of the locality.

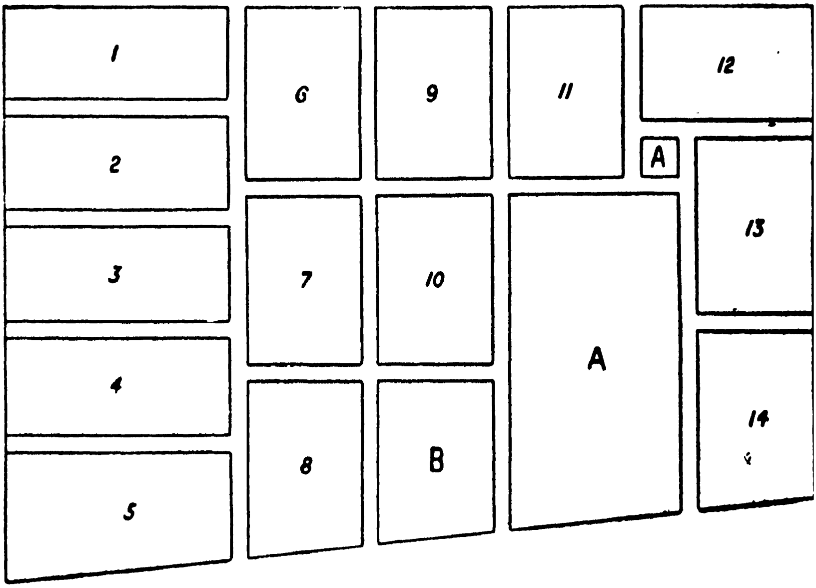
9. In nature lessons, kindness to animals and respect for life should always be impressed on the children.

SPECIMEN COURSES IN ACTUAL OPERATION IN ELEMENTARY SCHOOLS.

SCHEME A.

The following is the plan of the garden, and scheme of instruction at a village school with average attendance of 118, and with a staff consisting of Head Certificated Teacher, two Female Assistants (Article 50), and one Assistant under Article 68:—

GENERAL PLAN OF GARDEN.

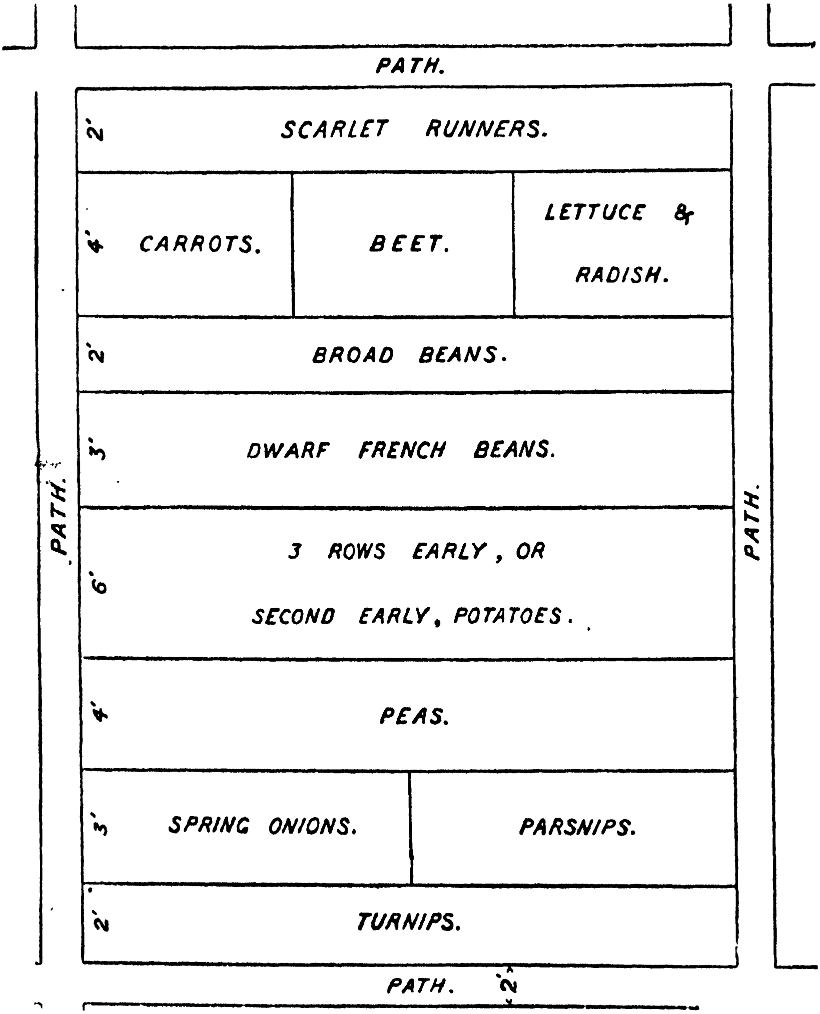


1—5 Garden Plots 33' x 14.
6—14 ,, ,, 26' x 16'.
A. A. Fruit Plots.
B. Nursery Plot.

Operations were begun with 7 forks, 7 spades, 7 draw hoes, 2 Dutch hoes, 6 rakes, and 2 garden lines: the cost of these was £3 9s. 6d. The stock of tools has since been augmented by the purchase of more forks, etc., a wheel-barrow, water pot, boat baskets and garden trowels. All seeds, with the exception of potato seed, are found by the managers and cost about 15s. each year. Manures (farmyard and chemical) cost 15s. annually, and the rent of the ground is £1. These expenses are met by the Government grant of £2 16s. 0d., and an Aid Grant of £2. On the fruit plots the following trees are grown:—Two pear trees, two apple trees, two plum trees, and one cherry tree. Some bush fruits are also grown. The boys are taught pruning, grafting, and budding, in addition to general fruit culture. The instruction is given once a week from 2.35 to 4.10 p.m. The boys stand round one of the plots, while the teacher demonstrates how each operation is to be carried out. Afterwards they disperse to their own plots and

each does the necessary work to the best of his ability. On wet afternoons the boys have talks about, and write compositions upon, the work which has been done or is to be done in the gardens. The instruction is continued throughout the year.

Each plot is cropped as follows :—

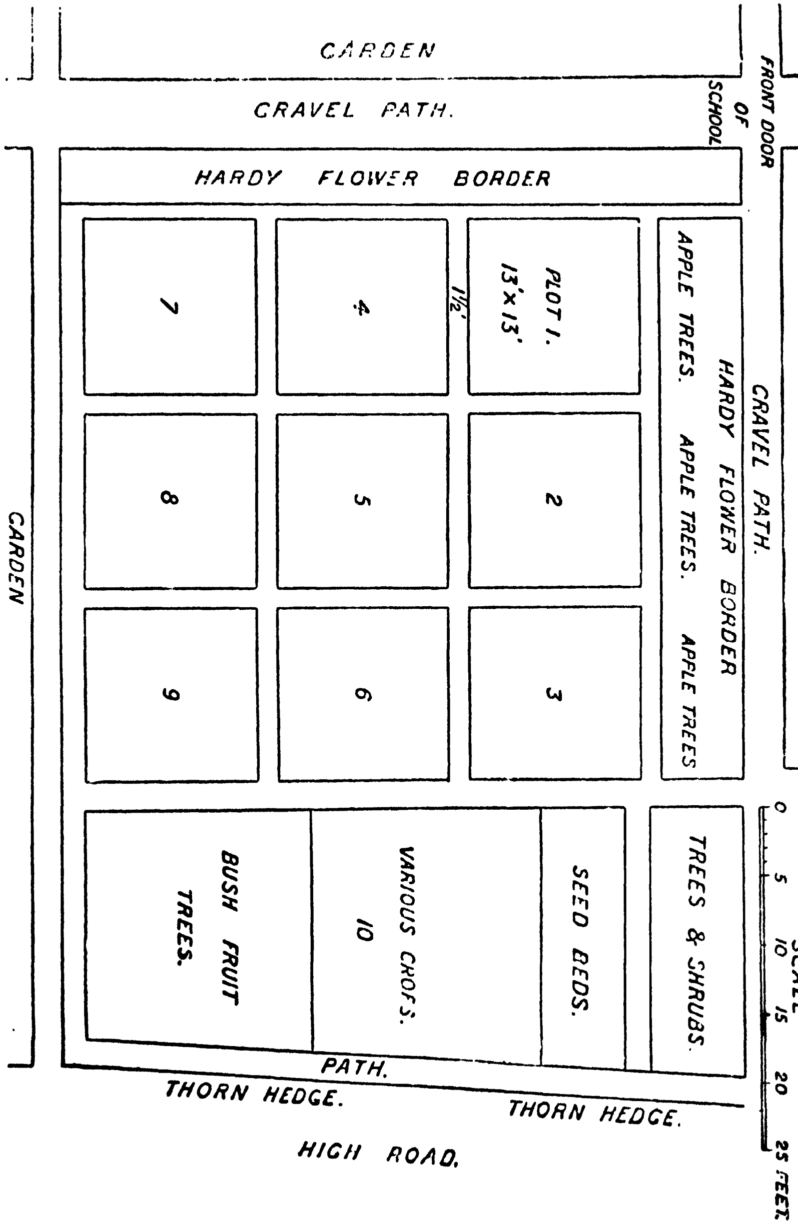


SCHEME B.

On the following page is the plan of a garden attached to a rural school with an average attendance of 100 under a Head Mistress, who takes the gardening class herself.

Each plot measures 13 feet by 13 feet. Plot No. 10 is used as a seed bed and for bush fruit trees and various crops, such as scarlet runners, tomatos, etc., for which there is no room on the other plots. Upon the other plots vegetables are grown in the following order:—Potatos, early and main crop (one

row each), carrots (two rows, one for exhibition and one for ordinary use), onions (two rows), beetroot (one row), turnips (one row), parsnips (one row), peas or French beans (one row). Lettuce is planted out and parsley sown as a border to the paths. Carrots and parsnips for exhibition are sown in holes made by a crowbar or long dibber, one foot apart, the holes are then filled with finely sifted soil in which about three seeds are sown. The crops are reversed from one end of the plots to the other in alternate years, running from East to West.



As a further means of changing the rotation they will be grown from North to South this year. After the summer crops have been lifted the refuse is burnt on each plot. All spare ground is then manured, dug, or trenched for the winter. The instruction is given for two hours each week, and rather more in the busy season. Lessons on plant and animal life in the lower standards as in Scheme VI of the Specimen Courses of Object Lessons already issued by the Board of Education. Visits to good gardens are found to be of great help. A record of the work done is kept by each boy, with notes on the soil, digging, pruning, manures, etc. The boys have additional practical instruction in root-pruning, pruning, and in growing strawberries and asparagus in the teacher's own garden. In winter and wet weather conversational lessons are given, illustrated by diagrams, pictures, magazines, etc.

SCHEME C.

The following scheme is in operation at a rural school with average attendance of about 120, with a small endowment, and staff of three certificated masters.

LOWER CLASSES.—STANDARDS I, II, AND III.

I. INSECT LIFE.

(i) *Three stages of insect life.*—Specimens to be brought by scholars. Caterpillars to be reared in building cages in school. Pupæ to be kept in shallow boxes of sand. Eggs of Common White Butterfly can be found on cabbage leaves.

[*Any common caterpillar or 'worm' will suffice: for instance, the sweet potato worm, the moth-borer (see 'West Indian Bulletin,' Vol. I, pp. 327-358) the 'arrowroot worm,' 'cassava worm,' etc.*]

(ii) *White Cabbage Butterfly.*—Life-history. Eggs, caterpillars and crysalides of this butterfly can be brought to school, and their development watched. Mischief done by butterfly; prevention and remedies.

[*A white cabbage butterfly occurs in the West Indies, but almost any other will do as well.*]

(iii) Lesson on a *Beetle*. Characteristics: Some beetles are useful as scavengers, others do much mischief to woodwork.

[*The 'hardback' affords a typical example of the first group. Amongst harmful West Indian beetles are the cacao beetle (see 'Agricultural News,' Vol. I, p. 9) and the ladybird borer or weevil borer (see 'West Indian Bulletin,' Vol. III, pp. 88-92.*]

(iv) *Ox Warble, Onion Fly, Magpie Moth, Gooseberry, and Currant Sawfly, Daddy Longlegs, Chick Beetle, Codlin Moth, Turnip Fly.*—The life-histories of some of these should be studied. The lessons should be of a practical character, and should all be illustrated by living specimens, and by Miss Ormerod's coloured drawings, as well as by blackboard sketches. The children should be encouraged to search cattle and garden and field plots for these pests, to keep account of the number found, to note the time of year when found, to hatch the

perfect insects from the pupæ, and to apply remedies possible for children to apply.

[*Amongst common West Indian examples are the cockroach, grasshoppers and crickets (see 'Nature Teaching,' p. 172), plant bugs or 'pea-chinks' ('Nature Teaching,' p. 173), scale insects (see Pamphlet No. 7, 'The Scale Insects of the Lesser Antilles,' Pt. 1), Screw Worm* (see Pamphlet on '*Screw Worm in St. Lucia*), *bees, flies, mosquitoes. The life-histories of most of these can be shown with comparatively little trouble.*]

II. Plant Life.

(i) *Germination of a seed.*—Lessons may be given on a broad bean in process of germination. Each child should have specimens to examine under the teacher's guidance. Acorns, chestnuts, and the seeds of the sycamore can be grown in small pots of soil.

[*Use Lima bean, Pigeon pea, Castor oil seed, Indian corn, pumpkin.*]

(ii) *Catkins.*—Alder and hazel catkins are to be seen before the birch and willow. Let the children examine their structure, and note the difference between the numbers of catkins and of cones. An alder, birch, and hazel tree bear both catkins and cones; a willow tree bears one or the other, but not both.

[*Plants bearing flowers in catkins are conspicuously absent from the tropics. The Casuarina affords a fair substitute. The male flowers are in little spikes and the female flowers form the hard, woody 'cones.'*]

(iii) *Leaves and roots.*—Kinds, varied forms of leaves and roots. Skeleton leaves can be formed by soaking the leaves in rain water for three or four weeks, and afterwards using a brush to the soft parts. Large, evenly formed leaves are suitable as objects for the drawing lesson.

(iv) *Local wild flowers* should be collected as suggested in Scheme I of the Specimen Courses of Object Lessons.

III. Animal Life.

Lessons on the *Bat, Rabbit, Mole,* and *Frog.* These lessons should deal entirely with the habits and characteristics of the creatures. Country children are particularly fond of noting the habits of the living creatures of the fields and hedgerows. The main idea of the lessons is to awaken interest in, and to encourage the observation of country things, thus making every rural walk full of interest.

[*The Bat, Rabbit, Toad or 'Crapeau,' Mungoose and Lizards might be adopted in the West Indies.*]

Intermediate Classes.—Standards IV and V

Nature Study.

A course of lessons can be arranged upon some of the following topics:—

1. Parts of a Plant.

2. Food of Plants.
3. Familiar Wild Flowers.
4. Common Garden Weeds.
5. Desirable Grasses.
6. Undesirable Grasses.
7. Insects injurious to (*a*) Flowers.
8. " " (*b*) Vegetables.
9. " " (*c*) Farm Crops.
10. Parasitic Insects.
11. Insect Allies.
12. Animal Pests.
13. Bird Pests.
14. The Farmer's Friends : (*a*) Animals.
15. " " (*b*) Birds.
16. " " (*c*) Earthworms.
17. British Wild Animals.
18. Fresh-water Fish.
19. Salt-water Fish.
20. The Whale.
21. The Sea Coast.
22. Brooks, Rivers and Canals.
23. Ponds and Lakes.
24. Mountains and Hills.
25. Rain and Hail.
26. Snow and Sleet.
27. Frost and Heat.
28. Thunder and Lightning.
29. Woods and Forests.
30. Moors and Fens.

UPPER CLASSES—STANDARDS VI AND VII.

Course for three years.

The whole series of lessons should be based upon observation and experiment.

FIRST YEAR'S COURSE.

Formation of Soils.—Formed from hard rocks by the action of the sea, rain, rivers, glaciers, frost, the oxygen and carbonic acid of the atmosphere, and the growth of plants.

Classification of Soils.

Influence of the mechanical condition of the soil upon the growth of plants.

Land-Surveying.—Use of Field Book, Land Chain, etc., for measuring areas. (Note: Take the boys out of school occasionally and measure some of the neighbouring fields. Each boy should have his own Field Book, in which to enter the necessary distances, etc., and afterwards the boys should be required to produce a plan of the field drawn to a suitable scale.)

SECOND AND THIRD YEARS' COURSE.

Structure of Plants.

Functions of (*a*) Roots, (*b*) Stem, (*c*) Leaves, (*d*) Flowers, (*e*) Seeds.

What is a Seed?—A seed contains (1) an embryo, or young plant, and (2) a store of nourishment to support the young plant until it is able to search for its own supplies of food.

Germination of Seeds.—Three conditions necessary, viz., (1) Air, (2) Warmth, (3) Moisture. (Note: To show the process of germination, get the boys to place a few seeds such as mustard, peas, maize, upon a piece of flannel moistened with water. Keep these in a suitable place, and each day carefully note the growth made by the seedlings.)

The Plumule, or young bud.

The Radicle, or first root.

How Plants feed.

Composition of Plants.—(*a*) Organic Substances.
(*b*) Inorganic Substances.

Plant Food obtained from (1) The Air.
(2) Pure Water.
(3) The Soil.

Composition of the Air.—Value (to Crops) of (*a*) Oxygen, (*b*) Nitrogen, (*c*) Carbonic Acid, (*d*) Ammonia.

WEEDS AND WILD FLOWERS.

Encourage the boys to make collections of Weeds and Wild flowers, to bring the specimens to school, and to preserve a collection of them. At the school at which the above scheme is in use, the upper boys in 1900 collected upwards of 200 distinct varieties, most of which were dried and mounted upon stiff paper.

SCHEME D.

The following scheme is in operation in connexion with a school in Kent which has an average attendance of about 120, exclusive of infants. The school is staffed by a Master and Mistress and an Assistant Mistress. Last year, the boys only of Standards IV to VI, were brought within the operation of the scheme; this year the class of about 60 scholars includes both the boys and the girls of these standards. The enlargement of the class has, up to the present, proved beneficial; but the problem of excursions with augmented numbers has yet to be solved.

SCHEME D.

SECTION I.—THE PLANT.

SEEDS.

Their structure and germination, using beans, barley and wheat, mustard, acorn, or hazel nut. Experiments to decide what seeds require as regards water, air, warmth, light, etc.

[*Beans, Indian corn, Guinea corn, mustard, nutmeg, coffee for the West Indies.*]

THE AIR.

Simple experiments illustrating the weight and other properties of the air. Experiments to show that burning, breath-

ing and the germination of seeds have the same effect on the air. Construction of the Barometer. Wind.

THE PLANT.

(*a*) *Distinction between root and shoot.* The different forms taken by the root—distinction between roots and underground stems—examination of carrots, leeks, bulbs, turnips, swedes, potatos, suckers of briars, etc. Functions of the root: show by a water culture the small amount of food drawn from the soil.

[*Carrots, yams, English and sweet potatos, arrowroot, ginger, onions, etc.* (*See 'Nature Teaching,' Chaps.* 2 & 3.]

(*b*) *Stems and buds.* Age of a twig; fruit buds and wood buds on apple, pear, plum, etc. Structure of a stem: pith, sap and heart wood, the growing layer. Formation of roots from the growing layer, as in cuttings. Healing of wounds on the stem, grafting and budding; how knots in timber arise.

(*c*) *Buds and leaves.* The coverings of a bud, the foldings of the leaf. The functions of the leaf—loss of water, feeding of the leaves upon the air, the effect of the light, the green colour, etc., the various shapes of leaves. [*The Bread Fruit affords a good example of leaf buds.*]

(*d*) *Flowers and seed.* The structure of the flower. Fertilization. Wind and insects. Catkins. Means for the dispersal of seeds. The forms taken by seeds and fruits.

(*e*) *The plant's life.* Getting and spending. Annuals and biennials. Bulbs. Tubers. Perennials. Species and individuals.

GRASSES AND WEEDS.

Making a collection. Names. Value. Eradication of weeds.

WATER.

How water changes into ice and steam. Expansion of water and other liquids on heating. The thermometer.

Evaporation of water and the cooling it produces.

Solution in water.

Good and bad water.

SOILS.

Visits to a quarry and a gravel pit, to see how soils are formed. Effect of frost. Sorting a soil into sand and clay. Experiments with clay to show its shrinkage, behaviour when puddled, etc., etc. Application to the working of a soil. Different kinds of soil, the trees and plants that grow on them. Signs of good and bad soil, want of drainage, etc. Gardening and farming operations. Ploughing and digging, cultivating and hoeing, harrowing and rolling. The seed bed.

Remarks.

The course is meant to take a year, beginning in January, for Standards IV., V., and VI. If necessary, Standard VI

could have an alternative course in 'weighing and measuring,' but the ordinary child will be all the better for one or more repetitions of the same course, especially as the master need never use the same illustrations two years in succession.

The outdoor experiments and excursions will fall naturally into the scheme.

January and February will be occupied with seeds, air, roots, and stems. Towards the end of February an excursion to a fruit plantation will be possible to examine fruit buds and spurs, etc., pruning, and so on.

In March comes an outdoor lesson in grafting and seed sowing.

April and May are good times for outdoor examination of buds, leaves, catkins, etc.

Experiments upon leaves in June; there will now be plenty of material for the lessons on the flower. A short time at the end of each lesson should now be given to grasses, which children soon learn to identify by their general aspect.

Budding forms an outdoor lesson in July; grasses, flowers, insects and sprays of trees and shrubs should be collected. In all outdoor excursions insects and buds should be watched; an informal lesson on the life-history of some insects can be worked in and followed up practically.

After the summer holidays an excursion can be made to a quarry or gravel pit; one or two more to learn the winter aspect of trees and shrubs.

[*The restrictions necessary in England owing to climatic conditions do not hold for the West Indies. The teachers must be guided by local conditions.*]

SECTION II. WEIGHTS AND MEASURES.

Alternative or Higher Course.

Comparisons of Measures of Lengths—the yard and metre, the centimetre and inch. The chain. Calculation of areas of regular figures and verification by means of squared paper. Examples of calculations of areas, papering walls, roofs and floors.

The Chain—its use in land measuring. Making a plan. Scales. Reading a plan.

The Cardinal Points—Motion of the sun. The compass. Finding a true North and South line. The sun-dial.

The Ordnance Survey and its maps.

Calculation of Volumes of simple figures and verification by experiment. Weights and volumes of water held by tanks, contents of haystacks, etc. Notions of density, the weight of materials.

STRUCTURES.

The lever and its various forms.

The simple mechanical powers—wheel and axle, pulley, inclined plane, toothed wheels.

Illustrations by experiment and from farm implements. Tension and compression. Stiffness of the triangle illustrated by the structure of the ordinary field gate and the kingpost truss. Tie-beams and struts. Beams and their shapes.

WATER.

Level of water in the ground.

Wells and springs.

Drainage plans and levels.

SCHEME E

The following suggestions in regard to object lessons in botany have been drawn up by the Essex County Council for the use of teachers in rural elementary schools. The course of instruction is intended to commence in the spring.

GENERAL CONDITIONS OF PLANT LIFE.

Select some dormant structure such as a potato tuber, turnip, bulb, seed, etc. Keep it under suitable conditions and get pupils to watch progress of growth.

[*The English potato, sweet potato, or yam may be employed as dormant tuberous bodies. For bulbs, use onions or lilies. Any seeds will serve.*]

Grow some specimens in the dark and others in the light and note the results, drawing special attention to the opposite effects of light in the cases of cylindrical and flat organs.

The pupils should note that as the shoots lengthen the tubers contract. Ask questions on these points.

Question on this point—

Get the pupils to obtain starch by washing 'grated' potato tubers.

Repeat the experiment with 'exhausted' or sprouted tubers.

In a similar way work out the germinating stage in the life-history of a bulb, a corn, pea or a bean seed, and compare with potato tuber.

Plant tubers in a box or in the garden bed for future demonstration in the formation and character of the present season's tubers.

In all cases note exactly *what* happens during growth, and as far as possible *how* it happens, together with the external conditions obtaining at the time.

THE DEVELOPMENT OF SHOOTS.

Study the structure of a cabbage with the class, drawing attention by means of a longitudinal section to the origin of leaves and the reason of their overlapping.

Distribute the buds from Brussels sprouts among the pupils and get them to make out for themselves the points previously drawn attention to in the cabbage.

Exhibit the section of an onion bulb, or of a hyacinth, and question on resemblance to 'sprouts.'

Get a mangold, a beet, a carrot, and a parsnip root kept over from last year. Cut them lengthwise. Get the pupils in turn to stand forward and insert long pins in such and such parts mentioned by you, with the object of getting the class to understand that the root part is simply a 'store-house' of food, and that the bud from which the shoot will arise is situated at the top in each case.

Crush the substance of the root of any of the above plants and pound it up with hot water. Pour the water out in a dish. Place it on a stove to evaporate. A sweet syrup will be obtained.

Pupils to remember that developing shoots require to be fed on such things as starch and sugar.

Plant out duplicates of the roots used in the lesson for future demonstration on important events in their life-history.

Study the buds of lime, lilac, and cherry trees, noting that some are flower-buds. Compare with the other buds examined.

[*The lime or other citrus plant might be employed, also Hibiscus, mahogany, etc.*]

These buds also must be fed. Where is the food stored? Demonstrate with tincture of iodine the presence of starch in the medullary rays of cherry, or in grape vine.

[*Grape vine can usually be obtained, and is excellent.*]

Study the '*spurs*' in a cherry tree. Note the differences in stem in this case--No internodes, more storage tissue, less wood.

[*Terminalia Buceras* (Bucida Buceras) *the Whitewood of Antigua, known as the 'Antigua Cedar' in Barbados affords a good example. The Avocado Pear is also fairly good.*]

Get the pupils to bring a collection of twigs. Help them to arrange the twigs according to some scheme. For example, write on the blackboard :--

I.	II.	III.
Buds opposite to one another on the stem.	Buds alternate first on one side then on the other.	Buds alternate and arranged in a spiral.
Ash, etc. [*Coleus, etc.*]	Elm, etc. [*Star apple, Sugar-cane, etc.*]	Apple, etc. [*Avocado Pear, Hibiscus, etc.*]

Let the pupils examine the twigs and from their observations fill up the schedule. Not only will an exercise like this give excellent practice in observation, but the children will, during such a lesson, easily learn the *names* of most of the trees and shrubs in the district.

With pins and thread show the spiral arrangement of the buds in one or two very evident cases.

Seeds and Seedlings.—Get the pupils to bring young plants of autumn-sown wheat. Draw attention to the young shoot

and roots, and especially to the old husk of the grain. Compare with spring sown wheat, barley and oats. [*Indian corn, Sorghum, etc.*]

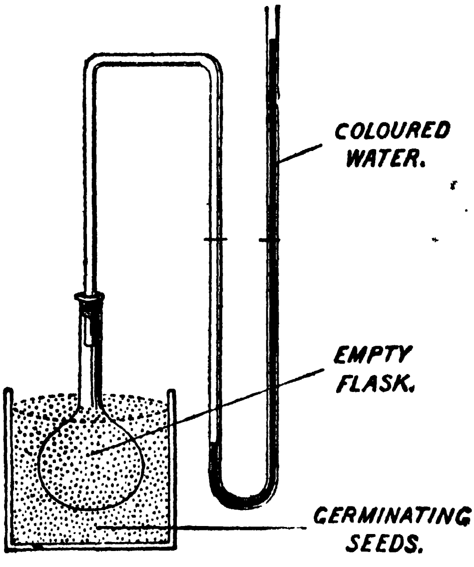
Get the pupils to see that the young plant has been feeding upon the same kind of food as we ourselves use in bread.

Study very carefully a broad bean after it has well begun to germinate. Draw special attention to the mode of germination and to the tap character of the root.

Prove that peas (and other seeds) absorb a large quantity of water when they are first placed in the soil. Burst bottle with expanding peas.

Prove that peas (etc.) during germination have the same effect on air as breathing animals. Pot some germinating peas (a score or so) in a large *stoppered* bottle, and keep in a warm place. Next day show that a candle or taper will not burn in the air within the bottle.

If the pupils can be made to understand what is proved, place an empty test-tube with the peas, and after the experiment show the presence of CO_2 by shaking up a little lime-water with the air in the tube. (Compare with air of schoolroom at beginning and end of lessons.)



Place an empty flask, to which a suitable bent tube is attached by means of a rubber cork, among a mass of germinating pea or barley seeds, and demonstrate the evolution of heat in the process of germination.

Plant peas (and other seeds studied) in boxes or pots, and see that the pupils put plenty of drainage material at the bottom.

Recall to them by questions that germinating or growing seeds need air, and make it quite plain that drainage is one good and necessary method of getting the soil supplied with renewals of fresh air.

In this connexion show the effect of mixing sand with heavy clay soil—how that it opens the soil, rendering it more porous.

Get the pupils to collect as many different kinds of germinating weed seeds as they can find in field and garden, and get them to distinguish between cotyledons and ordinary

foliage leaves. A few selected seedlings may be spread out in shallow water in a white plate in order to show the root-system clearly.

Excursion in Lane or Field in Spring.—Take the pupils out of doors, and draw attention to whatever points of interest you can find.

[*Somewhat similar observations can be made in the West Indies at the onset of the rainy season. The importance of water to plant life can then be pointed out.*]

You ought to go over the ground alone previously and take notes of the objects you think most interesting and instructive. At this season attention may be drawn to—

1. Buds, some like those of the ash, not yet started, others just started and in the very act of casting off the scale leaves. Others like those of the maple and horse chestnut, have formed lengths of shoots already. Draw special attention to the elongation of the internodes from below upwards, together with the characteristic folding of leaves in the bud.

2. Early flowers produced on certain trees and shrubs.

3. The pushing up of shoots from underground stems of perennial hedge plants.

4. The general and particular signs of Spring.

STUDY OF ROOTS.

Garden peas or beans form excellent material. Dig up a sufficient number soon after they have shown the green shoot. Give one to each pupil. Question them as to the origin of tap-root, the origin and arrangement of root branches, the position and extent of root-hair region, the naked tip.

Compare the roots of peas or beans with the root-systems of wheat, grass, onions (spring onion), etc.

Let the pupils make cuttings of young or sappy growths of geranium stems, and insert them in well aërated soil in pots. In about three weeks the cuttings will strike.

Remove the soil and see how each cutting has healed and formed 'adventitious' roots. Draw attention to badly healed specimens and question as to the causes of failure (if any).

Impress the importance of using a sharp clean knife, of making a level cut, of inserting with right firmness, in open and well drained soil, and of keeping the soil suitably watered (but not soaked) and at a proper temperature.

The origin and growth of roots on cuttings may be observed on the ends of willow twigs suspended in water, by means of cork or cotton wool.

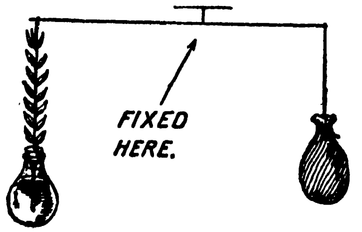
Put fragments of water-cress in bowls of water kept at the temperature of the room, and observe the origin of roots from the nodes. Get the pupils to note the time of their appearance.

Movement of water in plants.—Take a leafy shoot from any tree or shrub, put it in a vessel of water coloured red with eosin, and keep it in a warm room for twelve hours or so. (Several kinds of shoots may be so treated.)

[*Whilst almost any shoot will afford fairly good results, the colouration is excellently shown in plants with semi-transparent stems, such as balsams.*]

Get the pupils to observe that the veins of the leaves are red. By questioning them, make them see that the coloured water passed through the stem into the network of veins.

Distribute short lengths of the treated shoots, and ask the pupils to discover the exact pathway taken by the water by making transverse and longitudinal sections. Make a bold drawing on blackboard, leaving rind and pith uncoloured and, by means of an experiment, indicating the position of woody tissue by the use of the red chalk.



Follow this up by answering by means of an experiment the question, 'Why does the water move along the woody tissues and fill the "veins" of the leaf with watery sap?'

Fix a rapidly growing young shoot in a bottle of water by means of a sound cork, then balance it exactly on a rod against a bag of sand. The bottle and shoot will get lighter and the amount of water in the bottle will decrease. Why is this? Get the information by questioning the class.

Put a large leaf under an inverted tumbler on a smooth table. Expose it to strong light. Put another under a tumbler in the dark. Compare appearances after an hour or so. Question the pupils on the results and get correct answers.

Explain the importance of transpiration and show how forests for example, influence the physical geography of the district.

THE CULTIVATION OF ORANGES.

In the *Journal of the Royal Horticultural Society* (England) for April 1901, there is a lengthy article by Señor Alino, F.R.H.S., on 'The Cultivation of Oranges,' of which the following summary has been prepared by the Hon'ble Francis Watts, B.Sc., F.I.C., F.C.S. :—

The writer urges the importance of the systematic application of artificial manures in orange groves or orchards as being essential to profitable cultivation, and devotes his remarks almost entirely to the selection and use of suitable artificial manures, little being said about general cultivation. He points out that the orange tree is capable of adapting itself to a great variety of soils, but where irrigation is practised the writer prefers soils composed mainly of siliceous sand with some lime and clay, having a good depth, and capable during the summer

of receiving copious irrigation. . . . This soil is valuable principally for its physical properties, and, in a lesser degree, for its chemical composition.

In order to fix on the right fertilizer and to use it correctly, says the writer, one must be acquainted with the composition of the plant, its necessities, the quantity and condition of its products, the composition of the soil and the class of vegetation upon it. By these means we may know with an absolute certainty what elements should be employed and in what quantities, although later on he expresses the opinion that this method is not entirely trustworthy, and gives instances of its failing in the case of soda, of lime, and of potash.

The average results of many analyses, by the writer, of various parts of the orange tree are given.

	Nitrogen.	*Phosphoric acid.*	*Potash.*	*Total ash.*
Fresh Fruit	0·38	0·10	0·38	3·21
Fresh Leaf	0·70	0·10	0·38	6·00
Fresh Wood	0·70	0·50	0·73	7·00

The manurial substances removed in the fruit are regarded as the measure of the requirements of an orange orchard. On the supposition that a hectare of orange grove (2·471 acres) with about 250 trees, produces 30,000 kilos. (66,120 lb.) of fruit, according to the above analysis the crop contains:

Nitrogen	111 kilos. (251¼ lb) or 1·03	cwt. per acre.
Phosphoric acid	120 kilos. (264½ lb) or 1·08	,, ,,
Potash	111 kilos. (251¼ lb) or 1·03	,, ,,

and it will be necessary to return the above elements to the soil in one form or another if one wishes that the trees should not give way for want of nourishment, nor leave off yielding an abundant crop of good quality. Bearing in mind the aforesaid figures, the theoretical formula of a perfect chemical fertilizer for the orange per hectare (2·471 acres) will thus be:—

Nitrate of soda	760 kilos. (1,675 lb) 6·89	cwt. per acre.
Superphosphate of lime	705 kilos. (1,554 lb) 6·39	,, ,,
Sulphate of potash	225 kilos. (496 lb) 6·89	,, ,,

It is however clear that this formula cannot be rigidly adhered to: it must be modified in each particular case, in accordance with the composition of the soil, and the nature of the vegetation of the orchard. The formulae which will be given further on are based on this, and modified in accordance with the experience of some years.

Some interesting remarks are made as to the effect of various plant food substances upon the tree and upon the fruit.

An excess of nitrogen produces an exuberant growth of wood and foliage, which uselessly deprive the soil of mineral salts, whilst the resulting fruit is very coarse and thick-skinned with little sugar or aroma and of bad keeping capacity. The time of ripening is also retarded and it is necessary to consider whether this is or is not convenient. If, on the contrary, phosphoric acid is too abundant, the fruits

are small but numerous, well flavoured and aromatic, with thin skin and poor pulp. When potash is super-abundant, the tree does not grow very large, but the fruit is juicy, sweet, and of pleasant flavour. Accordingly none of these three elements takes the place of a complete fertilizer: they complement each other; they counteract each other's bad qualities and bring out the good: and if used together and in proper proportions, they produce the desired result.

The following formula is given for a fertilizer for young trees:—

Sulphate of ammonia	300	kilos.	(661 lb)	2·72	cwt. per acre.
or nitrate of soda	375	,,	(827 ,,)	3·40	,, ,,
Superphosphate of lime	300	,,	(661 ,,)	2·72	,, ,,
Chloride of potassium	60	,,	(132 ,,)	·54	,, ,,
Sulphate of lime	250	,,	(551 ,,)	2·26	,, ,,
Sulphate of iron	100	,,	(220 ,,)	·90	,, ,,

The use or non-use of gypsum in this formula produces very different results. When gypsum is employed the result is many little branches and much foliage; but the small branches are useless: they have little substance, and the leaves are large and far apart. The sulphate of lime somewhat lessens the expansion given to the plant by the nitrogen: consequently the shoots are not so long, but stronger, stouter, and better formed, and the leaves numerous, though of smaller size, closer grown, and more strongly united to the shoots. Various formulae are then given wherein such materials as pigeon dung, guano and horse dung are employed in combination with and, in part, substitution for the above substances. The advice is given to employ organic manures not oftener than in alternate years.

Except under the special conditions of the soil which make it necessary to decide for the exclusive use of the nitric or ammoniacal nitrogen, it is better to apply both forms of nitrogen. In February 200 kilos. (441 lb.) per hectare or 1·51 cwt. per acre of sulphate of ammonia, and in June 260 kilos. (551 lb.) per hectare or 2·35 cwt. per acre of nitrate of soda.

This again is followed by formulae suggesting the use of such substances as pigeon dung, sewage (dry), chrysalides of silkworms, sardine or other fish guano, horn and hoof parings (ground), and horse manure in part substitution for the above manures.

The somewhat startling theory is put forward that old orange trees are often unproductive on account of an accumulation of an excess of potash or lime in the tissues of the leaves and young branches, thus forming a kind of mineral net work at times so thick as to impede the circulation of the sap. The tissues become mineralised to excess, almost petrified, and this is an obstacle to the proper life of the plant. It is well in such cases to apply a fertilizer in which nitrogen and phosphates predominate; the first to accelerate the movement of the sap, and the second to promote the formation of new cells, and consequently that of new tissues, at the same time facilitating flowering and fructification. When the new tissues have gained

a predominance over the petrified ones, the vital activity is strong, and the tree grows again under normal conditions.

The use of manganese as a manure is recommended as a remedy for this 'petrified' condition of things, and manures are given containing a substance unknown to the writer of this article, namely, 'superphosphate of lime maganese (say, calcium of maganese).' As there is uncertainty as to the writer's meaning in this connexion, the reader is referred to the original article.

Orange trees with much wood, leaf and flower, but little fruit where the paucity of fruit is not known due to the variety of the orange but to defects in the soil, may owe their lack of fruit to a deficiency of nutrition, or to a deficiency of the phosphates which promote the fecundation of the ovary of the flower; or to the exaggerated predominance of nitrogen which by excessively expanding the sexual organ of the flowers produces its abortion. Whatever be the cause we must employ a fertilizer in which phosphates predominate. Nitrogen should be applied in small quantities, and if the leafage is excessive it may be omitted altogether. The use of sulphate of lime is beneficial, because the tree absorbs the greater part of the lime which, mineralising the tissues, modifies the excessive growth of the green organs, and makes the sap, now enriched by the phosphates, direct itself to the flowering parts or to the fruit-bearing branches.

It is advised that the whole of the nitrogen should not be given in one application but divided into two, part to be given in February and part in June. Suggestions are made for the hastening or retarding of the ripening of the fruit by applying artificial manures earlier or later, thus controlling the crop.

Throughout the article there is no reference to experimental results, everything is stated empirically. This is to be regretted as in the absence of field results one is at a loss to know how much weight to attach to the writer's views.

INSECT EPIDEMICS.

In the study of insect life, few things are of greater interest than the abnormal increase of a particular species, far beyond its usual limits. When this occurs in the case of an insect pest, the question becomes of greater importance owing to its bearing on agriculture, and it is then more easy to make observations as to the causes of this increase and the conditions that accompany it.

In closely studying the fauna of any locality, one observes constant changes in the relative numbers of the different species: an insect may be scarce for a long period, and then become abundant; and, equally, a species usually plentiful may decrease almost to extinction. There is constant variation

in this respect, and it is seldom possible to obtain any glimpse of the causes of these variations. With regard to insects that are confined to crops, the matter may be very different. The regular variation in the numbers of such a pest as moth-borer in sugar-cane soon becomes apparent, and the causes of this appear to be so simple that one is tempted to ascribe it almost wholly to the work of the egg parasites (see *West Indian Bulletin*, Vol. I, p. 316.) Probably many other cases, if studied sufficiently carefully, could be shown to be due to similar causes, and in many cases of pests in various parts of the world the causes of sudden increase and decrease are well established and familiar.

During the past years, there have been some interesting cases of rapid insect increase in the West Indies. Some are very sudden, the insect appearing in great numbers almost at once, only later to decrease equally suddenly. A familiar instance can be found in the sweet potato worm. (*Protoparce cingulata*, Fabr.) Planters of Barbados and Antigua will remember the hordes of worms which appeared, ate the potato vines, and soon disappeared: in some cases these worms re-appeared once and perhaps twice, but presently they vanished to re-appear no more that season. How do these things happen? The answer to this might have been found had we been able to observe very closely. It is possible to hazard an explanation if we suppose that as the young sweet potatos came up, there were a few moths ready to lay eggs. Each lays some hundred or more eggs, dotted about the potato fields, and since the worms that hatch are not many and are scattered, they escape the observation not only of the planters, but of the blackbirds and other enemies. There will then soon be some hundreds of moths from these worms. Suppose the majority of the females escape their enemies and lay eggs all in one locality. The eggs are not seen: the planter does not connect the 'Harry booby' moths he sees at night with an approaching attack of the potato worm; but in a few days these eggs hatch and vast numbers of worms are now seen. Not only does the planter see them, but also the birds, toads and insect enemies, chiefly parasites, of the worms. Many of the worms doubtless die, but there are so many that large numbers survive, are able to become moths, and if they remain in that locality they will give rise to a second horde of worms. In the case of the second horde, there are probably fewer chances of any surviving: their enemies have been attracted by the previous attack: their parasites are probably enormously abundant from their increase in the previous horde, and we can understand how the second horde is possibly exterminated. Should it survive in part, we get a third horde of worms, and this is usually the last. Their enemies and parasites are too strong. Few caterpillars escape, and the few that do turn to moths are barely sufficient to propagate the species. This is probably a very approximate idea of what actually takes place. Enemies and parasites are here the factor that puts an end to the sudden increase.

In other cases, another factor may be lack of food. Possibly this has a great bearing in the case of the St. Vincent arrowroot worm. (*Calpodes ethlius*, Cram.) Obviously, if the swarms of

worms absolutely eat all the arrowroot leaves, the butterflies will have nowhere to lay their eggs and the pest is bound to decrease.

In both the above cases, the suddenness of the attack is a striking feature, and this is so in many of the cases where an insect increases far beyond the normal limit. A similar case was found in 1901 in the attacks of the Guinea-grass moth (*Remigia repanda*, Fabr.) in San Fernando, Trinidad, where a considerable area of grass is reported to have been eaten by hordes of caterpillars. This attack was also seen in Grenada later in that year, and has this year been observed in Barbados. It would appear as if a *single* cause might underlie these three attacks, similar conditions or change of conditions producing similar effects in three separate localities. Mr. Hart was of opinion the cause of the San Fernando outbreak might be drought, but this would not apply to Grenada in 1901, or to Barbados in the middle of 1902. Probably where an outbreak cannot be studied very carefully for a considerable period of time, it is useless to speculate as to its origin, though we might frequently avert such outbreaks could we ascertain the causes that lead to them.

Some insect attacks, instead of being irregular and sudden, recur with something approaching regularity. Such a case is found in the caterpillar of the fiddle wood moth (*Pyrausta mellinalis*, Hubn.); though perhaps not entirely regular and periodic in its occurrence, this insect denudes the fiddle wood trees twice a year in Barbados, disappearing again after each outbreak for some months. The moth whose caterpillar eats lilies (*Euthisanotia amaryllidis*, Sepp.) is another fairly regular visitor and there are other common but unimportant cases of a like nature.

In other instances, the increase of the insect is slow and gradual. The occurrence of thrips in Grenada on cacao is probably a case of a native insect slowly becoming more for more abundant from natural causes. Had the thrips not attacked cacao, its increase would not have been observed, for we are seldom conscious of the increase of insects other than those that attack our crops. Since the thrips was found on cacao, its increase was presently noticed and the accounts given point clearly to the steady spread and multiplication of these insects. As has been pointed out, (*West Indian Bulletin*, Vol. II., p. 183) this may have been due solely to the destruction of its native food plants with corresponding abundance of a plant to which it easily adapted itself. Cases somewhat similar to this appear to be found in the screw worm of St. Lucia, and the grasshoppers of St. Kitt's, though it is not possible to estimate the causes to which they are due.

From these cases, it can readily be seen that every outbreak of any insect pest is of peculiar interest from the light it throws on the conditions of insect life generally. Unfortunately, they can only be studied on the spot. Planters and others who have opportunities of observing can do much in this way, and all observations of this nature are of interest and value.

The West Indies have not experienced any outbreaks similar to those which have occurred elsewhere, and this is

possibly due to the fact that these Colonies do not form part of a large continental area, but are isolated islands. As an instance of the damage done elsewhere by insect plagues, we may cite one, that of Massachusetts, where from 1893 to 1898 $800,000 were spent in fighting the Gipsy moth, an insect introduced by chance from Europe. It is to be hoped that the West Indies may never be visited by such a pest, there being a sufficient variety and number here already.

THE 'GREEN PAGE' MOTH.

(*Urania leilus* = *Cydimnon leilus.*)

The following account of a familiar West Indian insect is from the pen of M. L. Guppy, Junior, of Trinidad. The observations recorded are of interest as throwing light on the life-history of this moth, thereby filling a gap in our rather scanty knowledge of West Indian insects. In the *Agricultural News* (the fortnightly review of the Department) Vol. I., p. 56, there appeared a short note on this insect under the title of the 'Blue Page' moth, identified as *Urania sloanus*. Specimens were sent to the British Museum (Natural History) for confirmation of this identification, but Sir G. F. Hampson has determined them as the Green Page, *Urania lëilus*. The note referred to on page 56 has been corrected on page 168 of the same volume of the *Agricultural News*. The insect referred to in these two notes is the one here dealt with by Mr. Guppy :—

This insect appeared in immense numbers in Trinidad during the months of July, August and September of 1901. The moths seemed in many places to have taken up their quarters, instead of flying in their usual business-like manner, never in flocks, but singly and all in one direction. In certain places I was very suspicious of their homelike appearance, not observed by me before, and extremely puzzled at the fact that though there were such numbers flying in the usual manner, a few were taking things easy, and, as I observed in Tunapuna, appeared to be depositing eggs. This surmise proved correct. Still my opinion is that the green page moths in Trinidad are mainly migratory, but that here and there an erratic female deposits eggs on the food plant in suitable places. The majority come over from Venezuela in immense numbers beginning in July or August, and after collecting like swallows at various points along the coast, they return to Venezuela in October or thereabouts. Some years very few are seen in Trinidad, but throughout the year solitary specimens may be seen here and there far apart along the borders of high woods One may see only a single specimen in a day's ride.

In Tunapuna on September 13, 1901, after observing how attentive some of these beautiful insects were to a certain creeper, (kindly identified for me by Mr. J. H. Hart, F.L.S., as

Omphalea megacarpa, Hemsley) I was fortunate enough to find about a dozen eggs, and although I searched high and low for more eggs, I never found more than six or thereabouts, and there was nothing to show that there were many larvae about. At any rate I only found two.

Cydimon leilus is the typical species of the genus. It was first figured by Madam Merian as early as 1705. She shows the larva as possessing long branching spines 'as hard as iron wire.' This, however, is incorrect.

The *egg* is spherical with a circular space at the top from which rise twenty odd longitudinal ribs. The eggs are at first pearly white and yellow later.

The *larva* (which has the usual sixteen legs) is white (or faintly tinted blue) with eleven transverse black lines and a fine, sparse down. The head is black. After the first moult the head becomes yellowish red with black dots, and on the body appear eight, long fine black hairs slightly thickened at the tips which are tipped with white. The third and tenth segments are now almost entirely black.

After the second moult two additional long black hairs appear and the black transverse lines broaden. Subsequent to the third moult two more long hairs appear projecting over the twelfth segment like a pair of tails. The larva now shows a lateral row of white spots and the first segment is black and red. The body is by this time black and white with irregular transverse wavy lines and white areas edged with black. Sometimes the ground colour is greyish-lilac with central broad black transverse lines and two dorsal rows of white spots.

After the third moult the ground colour of the larvae varies a good deal, but after the fourth and last moult, it is usually almost black. Probably, however, many lilac tinted examples may be found

The head and feet are always yellowish-red with black spots; the thoracic feet of the same colour and the claspers almost white. The long hairs remain throughout, black with white points. The hairs are usually twelve in all, two on each segment, from the fourth to the ninth, and remain soft in texture. The body is sparsely downy The larva is two inches long when fully grown and of normal form. It is active and a day feeder.

The *pupa* is light yellowish brown with black dots and lines, and is formed in a light and roomy cocoon of yellowish-red silk through which it can be seen.

The following *Cydimons*, all of which inhabit Tropical America, are known :—

(Mr. Kirby says that the name *Urania* cannot be retained, as it was previously given to a genus of plants*)

* It will be noticed that Sir G. F. Hampson places the insect in the genus *Urania*. (Ed. *W.I.B.*)

1. *Cydimon leilus*—common in northern parts of South America.
2. *C brasiliensis*—common in Brazil, very like *C. leilus*.
3. *C. boisduvalii*—common in Cuba, the larva feeds on *Omphalea triandra*.
4. *C. fulgens*—common in Mexico and Central America, remarkable for its migratory habits.
5. *C. sloanus*—confined to the island of Jamaica, the smallest of the genus.

Omphalea triandra yields a sweet and wholesome fruit called the Cob or Hag-nut in Jamacia. It forms a tree about fifteen feet high on the sandy shores of Cuba.

The imago of *Cydimon leilus* is very fond of 'black sage' flowers and other small white flowers that grow on low shrubs. I have seen them sucking the flowers in hundreds on a long 'black sage' hedge in Cunuto.

THE GUINEA-GRASS MOTH.

(*Remigia repanda*. Fabr.)

In July 1901, Mr. J. H. Hart, F.L.S., Superintendent of the Royal Botanic Gardens, Trinidad, forwarded some specimens of a moth found to be destructive to grasses at San Fernando, Trinidad. Examples were forwarded to the British Museum (Natural History) for identification, and were determined as *Remigia repanda*. Fabr. Mr. Hart reported on the occurrence of this pest at San Fernando* and estimated the loss at 70 per cent. of the food value of the grass crop. Later in the year a report was received from Mr. W. E. Broadway, the Curator of the Botanic Station, Grenada, of the damage by caterpillars to the grasses at Government House, in that colony. Mr. Broadway sent specimens of the caterpillars and of moths raised from them; they proved to be identical with the Trinidad species.

During May, June and July of this year the same insect has proved injurious to Guinea-grass (*Panicum maximum*, Jacq.) in Barbados. It was probably at work also in 1901, as Dr. John Hutson, M.B., noticed the attack of a caterpillar on Para grass (*Panicum muticum*, Forsk.) in Bridgetown towards the end of 1901; but no notice was taken of it until in May 1902, it commenced more serious destruction. The Rev. N. B Watson, B.A., of St. Martin's, Barbados, has reared the insect from the egg and followed it through its stages; his observations are here given in full:—

Egg—The eggs of this moth are deposited in masses of forty to sixty close to the midrib on the under surface of the leaf blade.

*Report on Caterpillar Plague in Paradise, San Fernando, July 8, 1901.

They are small, yellowish-brown, and are easily visible without the aid of a glass. Under an ordinary pocket lens, they are seen to be melon-shaped, resembling miniature fruits of the sandbox tree (*Hura crepitans*) with ribs like the meridian lines of a globe running from the base of the micropyle at their apex outwardly, and downwards along the sides to the base of their attachment. When mature, the eggs are of a dark bluish-gray colour, when hatched, the empty shells are metallic ash-gray.

Larva—In five days the tiny caterpillar emerges from the egg by boring its way through the side of the shell just below the micropyle at the apex. On hatching, it immediately attacks its food, and does not begin upon the empty shell from which it has emerged, as is the larval habit of most lepidoptera. Its size at this time is very minute, scarcely exceeding $\frac{1}{20}$ of an inch, but in five days it will have grown to the length of $\frac{1}{5}$ inch.

In twenty days, when it has attained its full size, about $1\frac{1}{4}$ inches, the caterpillar becomes uneasy, quits its food, and wanders from leaf to leaf in search of a convenient situation for its pupation. When a suitable leaf is found, the larva at once begins to prepare for its metamorphosis by spinning for its protection a delicate, but strong pocket of silk of the same colour as the egg—on the inner and concave surface of the leaf.

Two days are required to weave its cocoon and change into the chrysalis.

Pupa—The chrysalis, which is $\frac{7}{10}$ of an inch long, is at first of a light amber colour, but grows darker as the future moth within is developed. The pupal state lasts but six days, during which time, suspended head-downwards, it remains inactive, save for an occasional wriggle of the abdomen to scare off intruders.

Imago—At the end of six days, the delicate and transparent skin bursts open across the thorax, the moth quickly comes forth, and clinging to the side of its cocoon, remains there until its elongated abdomen is contracted, and its moist and crumpled wings are expanded and dried. Like the woolly-pyrol moth (*Thermesia gemmatalis*) these moths are not all of the same colour, nor are they similarly marked. Moths from the same batch vary from light-brown-red to dark-gray. Their colours are always sombre and the markings faint and obscure The antennae are elongated and filiform. In the female, the tibia and tarsi of the posterior pair of legs are scopiform; in the male, the femur and tibia of the two posterior pairs of legs are spinose.

The moth lives six days.

June 4, '02	Egg	5	days.	Attached to under side of leaf, near midrib.
	Larva	20	„	Feeding on the leaf.
	„	2	„	Building cocoon and pupating.
	Pupa	6	„	In cocoon, which is partly enclosed by leaf.
	Imago	6	„	Paring and flying about to deposit eggs.
		—		
		39	„	

This insect is recorded from Trinidad by Mr. W. J. Kaye, F.E.S.,(1) and he states its range to be 'Brazil, Jamaica, Canada Central Africa.'

Sir George F. Hampson (2) records it from St. Vincent and Grenada among the specimens collected by Mr. H. H. Smith. It is probable that the insect is to be found throughout the West Indies. Another species (*Remigia disseverans*, Walk.) is recorded in Jamaica by Mr. A. G. Butler (3) and in Dominica by Mr. H. Druce, (4) and a third, *Remigia latipes*. Green., in St. Lucia, Dominica and Grenada by Sir George F. Hampson.(2)

SCALE INSECTS OF THE WEST INDIES.

BY H. MAXWELL-LEFROY, M.A., F.E.S., F.Z.S.

Entomologist to the Imperial Department of Agriculture for the West Indies.

I have to acknowledge, with many thanks, the assistance rendered to me both by collectors in forwarding specimens and by those students of this group who have kindly assisted in determining the species.

To the Curators of the Botanic Stations I am indebted for much material sent me by Mr. Broadway from Grenada, Mr. Powell from St. Vincent, Mr. Moore from St. Lucia, Mr. Jones from Dominica, Mr. Jordan from Montserrat, Mr. Sands from Antigua, and Mr. Lunt from St. Kitt's. In Barbados, I owe specimens to many contributors, above all to Mr. J. R. Bovell, F.C.S., F.L.S.

To the courtesy of Dr. L. O. Howard, United States Department of Agriculture, I owe the determination of material by Messrs. C. L. Marlatt, T. Pergande and P. Kotinsky. Mr. T. D. A. Cockerell has readily given assistance in literature and in reporting on doubtful species. Mr. E. E. Green, F.E.S., sent a valuable series of Coccids from Ceylon, Mr. J. H. Hart, F.L.S., kindly sent me the Trinidad *Coccidae* determined by Mr. Cockerell, and to Mr. F. Watts, B.Sc., F.I.C., F.C.S., I am indebted for Mr. C. A. Barber's Antigua *Coccidae*.

INTRODUCTION.

The following pages are written primarily to record the species found in the smaller British West Indian islands, with

(1) 'Lepidoptera Heterocera of Trinidad.' *Transactions Entomological Society*, London, 1901, p. 115.

(2) 'Moths of the Lesser Antilles.' *Transactions Entomological Society*, London, 1898, p. 25.

(3) 'On a small collection of Lepidoptera from Jamaica.' *Proceedings Zoological Society*, London, 1878, p. 480.

(4) 'On a collection of Heterocera from Dominica.' *Proceedings Zoological Society*, London, 1884, p. 321.

the observations made during the past two years' work. It has seemed desirable to bring together all records of scale insects throughout the West Indian islands, and I have therefore included the species recorded from Trinidad, Jamaica, Porto Rico, Cuba and Guadeloupe.

The islands constituting the whole West Indies form a rough semi-circle from the Southern United States to the mainland of South America, and may geographically be classed together. Zoologically we may divide them into three groups :—

(1) The Greater Antilles, including Jamaica, Hayti, Cuba, Porto Rico and the islands as far as the Anegada channel, the fauna of which may be most closely allied to that of Florida or Yucatan.

(2) The Lesser Antilles, from the Anegada channel south to Grenada, including the British islands St. Kitt's, Nevis, Antigua, Montserrat, Dominica, St. Lucia, Barbados, St. Vincent, and Grenada; the French islands Guadeloupe and Martinique, and various smaller islands.

(3) Trinidad and Tobago, reckoned here as belonging to the mainland of South America.

All the observations recorded in the following pages refer to the Coccids of the 'Lesser Antilles' as here defined. Probably these islands form a fairly definite zoological area. The very striking evidence of the land mollusca fully upholds this view, which is supported by the geographical evidence and by general zoological considerations.

At the present time we cannot generalise closely as to the Coccid fauna of the whole region. The records from Hayti, St. Domingo, Cuba and Porto Rico are too meagre, nor have I been able to obtain information as to the Coccidae of Guadeloupe and Martinique. Possibly this paper may afford a useful summary of our present knowledge, serving as a basis for further work.

An attempt is made to distinguish native from introduced species. The increasing spread of species over the globe renders this a hazardous task, but in view of its importance, the attempt, even if not successful, may be of value.

Information as to the destructiveness of these insects has been published in *Scale Insects of the Lesser Antilles* in two parts, issued in the pamphlet series of the Imperial Department of Agriculture for the West Indies.

LITERATURE.

The *Coccidae* of the West Indies have received able treatment at the hands of Mr. T. D. A. Cockerell, and I have in the succeeding pages no new species to add to those he has described, though some are awaiting further investigation.

A summary of Mr. Cockerell's observations is to be found in the *Bulletin of the Botanical Department, Jamaica*, in a series of articles extending from February, 1893, to May, 1898. These summarise the observations on the scale insects of all

the West Indies as then known, and I have added no facts with regard to the *Coccidae* of either Jamaica or Trinidad. The technical descriptions of Mr. Cockerell's new species are to be found in a variety of publications, far too many for me to attempt to enumerate. With Mr. Cockerell's assistance, I have been able to give a reference under each species to the original, or to some authentic description.

The *Coccidae* of Trinidad were dealt with in an appendix to the *Trinidad Bulletin* of April, 1896, and the *Coccidae* of Grenada in an article in the *Journal of the Trinidad Field Naturalist's Club*, Vol. II, No. 12, 1896.

For a more complete list of the observations of Mr. Cockerell the reader must consult the following publications (1892-98): –

Journal of the Institute of Jamaica. Journal of the Trinidad Field Naturalist's Club. Transactions of the American Entomological Society. Entomologist's Monthly Magazine. Transactions of the Entomological Society of London. The Entomologist. Insect Life. Psyche. The Entomological Magazine. The Canadian Entomologist. The Entomological News. Science. The American Naturalist. Science Gossip.

Mr. A. C. F. Morgan has made observations on the *Coccidae* of these islands, recorded in the *Entomologist's Monthly Magazine*, as has also Mr. F. W. Douglas.

Mr. Cockerell's observations on *Coccidae* outside of Jamaica were from specimens sent him by various collectors including Mr. J. H. Hart, F.L.S., Mr. F. W. Urich, F.E.S., Mr. L. Guppy, Mr. W. E. Broadway, Mr. C. A. Barber, and Mr. W. Lunt.

LIST OF SPECIES.

ASPIDIOTUS.

1* *Aspidiotus* (Selenaspis) *articulatus.* Morg.

A. C. F. Morgan, *Entomologist's Monthly Magazine*, August 1889, p. 352.

A native of the neotropical region, described from Demerara, since found in Brazil (Hempel), Mexico (Ckll.), the Southern United States and recorded under glass in England (Newst.).

It occurs abundantly throughout these islands; in Jamaica it is a serious enemy of citrus plants and palms (Ckll.), in Porto Rico Mr. A. Busck found it on orange, whilst in all the Lesser Antilles it occurs but rarely on palms, though commonly on citrus. It has a large number of food plants, both habitual

* The species are numbered in order in two series. The numbers in brackets refer to the whole series as found in the West Indies, the open numbers only denoting the species found in the Lesser Antilles.—(H. M. L.)

and occasional, the former including Liberian coffee, tamarind *Galba*, *Tabernaemontana*, etc.

It has a curious habit of living on either side of the leaf. Most *Coccidae* prefer the under side, but this species is commonly found on the upper side, exposed to the sun. No males appear to occur.

2. *Aspidiotus* (Euaspidiotus) *biformis*. Ckll.

T. D. A. Cockerell, *Gardeners' Chronicle*, May 6, 1893, p. 548.

This species is as yet recorded only from the West Indies and Central America. Mr. Cockerell describes it from Jamaica and Trinidad and it has since been found in Grenada, St. Lucia and Antigua. Its food plants are confined to orchids, on which it was probably imported to the three latter localities. It is a harmless species, increasing slowly in number. The male scales occur in about equal number with the female.

(3) *var. *Cattleyae*. Ckll.

T. D. A. Cockerell, *Gardeners' Chronicle*, May 6, 1893, p. 548.

Described from Jamaica.

(4) var. *Odontoglossi*. Ckll.

T. D. A. Cockerell, *Gardeners' Chronicle*, May 6, 1893, p. 548.

Described from Jamaica.

3. (5) *Aspidiotus* (Euaspidiotus) *cydoniae*. Comst.

J. H. Comstock, *Report United States Department of Agriculture*, 1880, p. 295.

A doubtful neotropical species, described from the United States, recorded from Samoa (Mask.), Ceylon (Green) and since found in Barbados, Montserrat, Antigua and St. Kitt's.

It is a curiously shy species as a rule, found in small numbers on the lower parts of the stems of the grape vine and *Canavalia*.

Only in St. Kitt's has it proved numerous, infesting Central American Rubber (*Castilloa elastica*), guava, *Muehlenbeckia platyclada*, and a palm (*Martinezia*.)

* The species are numbered in order in two series. The numbers in brackets refer to the whole series as found in the West Indies, the open numbers only denoting the species found in the Lesser Antilles.—(H. M. L.)

4. (6) *Aspidiotus* (Aspidiella) *Hartii.* Ckll.

T. D. A. Cockerell. New North American Coccidae. *Psyche,* January 1895. Supt. p. 7.

This West Indian species is so far confined to Trinidad (Ckll.), Grenada, Barbados, and Jamaica. It lives on yams and eddoes (*Dioscorea* and *Colocasia*), inhabiting only the tubers, which become covered with the scales if kept for a sufficient length of time. How the insects live from one crop time to another is not known, and it is hard to understand how successive crops become infected unless this species also lives on the roots of some wild plant. The uniformly high temperature of these regions hastens development, as a rule, and allows of no hibernating period, so that this scale, like *Aspidiotus sacchari,* probably has wild food plants.

(7) var. *Luntii.* Ckll.

T. D. A. Cockerell. *Trinidad Bulletin,* May 1896. Appendix.

A light coloured variety, found in Trinidad, was named after its finder, and appears to be peculiar to that island.

5. (8) *Aspidiotus* (Aspidiella) *sacchari.* Ckll.

T. D. A. Cockerell. *Journal Institute Jamaica,* Vol. 1., p. 255.

This species, described from Jamaica, is probably a West Indian species. Mr. Cockerell informs me that it has been recently found in Java. It is now plentiful in Barbados and Antigua on sugar-cane and Bahama grass. On the cane it lives under the leaf-sheaths, directly on the cane itself, but on the Bahama or Devil grass (*Cynodon Dactylon*) it infests the underground rhizomes. In outward appearance it closely resembles the yam scale (*A. Hartii*) and agrees further with it in having the thick ventral scale which remains on the plant when the insect is removed.

6. (9) *Aspidiotus* (Euaspidiotus) *destructor.* Sign.

V. Signoret, *Essai,* p. 94. (*Aspidiotus fallax,* Ckll. *A. palmarum,* Ckll. *A. cocotis.* Newst.)

This species, originally described from Réunion, is also recorded from the Laccadive Islands (Maskell) and Ceylon (Green). Signoret's description is not sufficiently full and Mr. Maskell regarded the distinctive feature of this species as the two median lobes being shorter than the others. If this character distinguishes it sufficiently from *A. hederae* and other species, this species does certainly occur in these islands. A large series of specimens have been collected in the smaller islands and whilst some were referred to as *A. destructor,* others were regarded as being doubtful.

All attempts to separate my specimens into two species fail completely, and I regard them all as *A. destructor,* with a

considerable range of variation as regards (1) comparative length of the median lobes, (2) spinnerets cylindrical or filiform, and (3) character of the puparium. Attempts to separate them on these characters give two series for each character, with intermediates, but the different series do not correspond.

I have compared specimens of *A. destructor* from Mr. Green in Ceylon and from Mr. Cockerell, and Mr. Green examined West Indian specimens and pronounced them to be *A. destructor*. All the specimens I have obtained from these islands I therefore refer to *A. destructor*, though careful study of the whole series by some later student may show some of my specimens to be *A. hederae*.

I have also had the privilege of examining the specimens of *A. hederae* in the collection of *Coccidae* at the Division of Entomology, United States Department of Agriculture, Washington, D. C., and am assured that I have never found *A. hederae* in the West Indies. All my specimens are closer to *A. destructor* than to *A. hederae*, and the latter is now rare or absent from the Lesser Antilles.

Mr. A. Busck found it in Porto Rico, Mr. Cockerell records it from Jamaica and Trinidad, Antigua and Barbados. It now occurs in Grenada, Barbados, St. Lucia, Dominica, Montserrat, Antigua and St. Kitt's.

The food plants include a very large number of occasional ones, besides the cocoa-nut palm, *Dictyospermum*, *Thrinax*, *Hydriastele*, *Hyophorbe*, *Oreodoxa*, *Pritchardia*, and other palms, which are almost habitual food plants. It also infests breadfruit, yams, *(Dioscorea)*, banana, *Cycas*, mango, nutmeg, Avocado pear, guava, and other cultivated plants habitually. Male scales occur and the scales of both sexes lie almost touching, massed together on the leaves in enormous numbers. Mr. Cockerell regards it as a native of the tropics of the Old World, and it would not appear to be a native of the West Indies. No scale is so destructive at the present time in these islands, and it is to be hoped it may not spread to new localities in tropical or sub-tropical regions. It should prove a formidable pest to green-house plants when once introduced.

7. (10) *Aspidiotus* (Aonidiella) *aurantii*. Mask.

W. M. Maskell. *Transactions of the New Zealand Institute*, 1878, p. 199.

This world-wide species appears to have been introduced into the West Indies; elsewhere it is known from Italy (Leonardi), Australia (Maskell), Cyprus (Shipley), California (Comst.), Ceylon and India (Green), and Mr. Newstead has it in England on imported oranges, probably from the Mediterranean. In the West Indies it occurs in Jamaica *(*Ckll.*)*, Porto Rico (Busck*)*, and is now to be found in Barbados, Montserrat, Antigua, and St. Kitt's.

In Jamaica it prefers lignum-vitae, rarely attacking citrus, and in the smaller islands its usual food plant is the ochro *(Hibiscus esculentus)*, though it has been found on the lime,

(*Citrus medica*, var. *acida*), in Montserrat, Antigua and St. Kitt's.

As in Jamaica, it is, in the latter localities, not a common pest of the citrus plants which grow so abundantly, its place being taken by *A. articulatus.* In view of the considerable range of food plants it has elsewhere and its predilection for citrus, its habits here are distinctly noteworthy, and the 'ochro' form, though morphologically indistinguishable, may be regarded as a physiological variety.

8. (11) *Aspidiotus* (Aonidiella) *personatus.* Comst.

J. H. Comstock, *Second Report on Scale Insects*, 1883, p. 66.

A neotropical species, described from Cuba, since found at Kew (Green), Mexico and Jamaica (Ckll). Porto Rico (Busck), and Demerara (Dougl). It is now common in Grenada, Barbados, St. Lucia, Dominica, Antigua and Martinique. In these localities it infests *Carissa edulis*, *Ficus nitida*, *Jasminum pubescens*, mammee apple, mango and screw-pine. No male scales have been found.

9. (12) *Aspidiotus* (Chrysomphalus) *dictyospermi.* Morg.

A. C. F. Morgan, *Entomologist's Monthly Magazine*, 1899, p. 352.

This is probably a neotropical species. It was described from Demerara, Mr. Cockerell has it from Mexico, Mr. King from Canadian hot-houses, and Mr. Maskell recorded it from India. It has been found in Trinidad and Jamaica (Ckll.) and now occurs in Grenada and Barbados.

A variety, *arecae*, is found in Demerara and Brazil and Mr. Newstead finds it in English hot-houses. I am uncertain whether it can be said to occur in Barbados or Grenada. Living specimens in these islands have a somewhat darker puparium than Mr. Morgan describes, and dried specimens frequently become greyish in colour.

Its food plants are cultivated roses and screw-pine (*Pandanus*). It would appear to have been introduced to these islands and may have come from the mainland of South America or from Mexico.

(13) Var. *Jamaicensis.* Ckll.

T. D. A. Cockerell, *Jamaica Bulletin*, Feb. 1898, p. 43.
Described from Jamaica.

10. (14) *Aspidiotus* (Chrysomphalus) *ficus.* Ashm.

W. H. Ashmead, *American Entomologist*, 1880, p. 267.

This species originates apparently in the neotropical region, possibly in Cuba or Jamaica. It is recorded from Florida and Cuba, (Comstock,) Porto Rico (Busck), Egypt (Newstead), India (Maskell), Ceylon and Kew (Green), and Italy (Leonardi).

Mr. Cockerell records it in Jamaica on a variety of plants, and it is now found in Barbados and St. Lucia. In the latter localities it has the appearance of an introduced species. In Barbados I found it on recently imported grape-fruit plants, as also on roses, *Cycas*, etc., and in St. Lucia it has been found on citrus only.

It is curiously slow in development and does not spread easily. Male scales occur with the female. It is much to be hoped this species will not become established on citrus in these islands.

11. (15) *Aspidiotus* (Pseudaonidia) *tesseratus*. De Charmoy. *Proc. Society Amicale Scient.*, p. 23. (1899).

This species was found on the stem of a grape vine at Antigua and has not been otherwise recorded from the West Indies. Mr. Cockerell informs me it was probably introduced from the Old World tropics.

I am indebted, through the courtesy of Dr. L. O. Howard, to Mr. Kotinsky for the determination of this species.

In addition to the above twelve species, Mr. Cockerell has recorded the following, which I have not found in the smaller islands:—

(16) *A. Bowreyi* Ckll. in Jamaica.
—*Entomological News*, 1894, p. 59—*Journal of the Institute of Jamaica*, I, p. 383.

(17) *A. lateralis*. Ckll. in Jamaica, originally described as a variety of *A. diffinis*, now regarded as more likely to be a variety of *A. punicae* (Ckll. in litt.)
—*Canadian Entomologist*, xxvi, p. 139.

(18) *A. mangiferae*. Ckll. in Jamaica, a possible variety of *A. dictyospermi*.
—*Journal of the Institute of Jamaica*, I, p. 255.

(19) *A. palmae*. Ckll. in Jamaica and Trinidad.
—*Entomological Magazine*, xxix, pp. 40 & 80.

12. (20) *A. punicae*. Ckll. in Jamaica and Dominica.
—*Journal of the Institute of Jamaica*, 1893, p. 225.

13. (21) *A. camelliae*. Comst. in Jamaica (*sub A. rapax*) and Antigua.
—*Report U. S. Department of Agriculture*, 1880, p. 307.

(22) *A. uvae*, Comst. in Jamaica.
—*Report U. S. Department of Agriculture*, 1880. p. 308.

14. (23) *A. hederae*. Vall. in Antigua, (*sub A. nerii*)
—in Grenada, (*sub A. hederae*, var. *nerii*)
V. Signoret, *Essai*, p. 66.

FIORINIA.

15. (24) *Fiorinia Fioriniae.* Targ-Tozz.

F. camelliae. Comst. *Report U. S. Department of Agriculture*, 1880, p. 329.

This species, found in Europe (Targ-Tozz.), United States (Comst.), Ceylon and Australia (Green), and Brazil (Ckll.), is recorded from Jamaica (Ckll.) and Barbados (Morgan). I have not met with this species, but it probably occurs on the cocoa-nut palm, which harbours many Coccids and which is its recorded food plant for both the above West Indian localities.

PARLATORIA.

16. (25) *Parlatoria proteus*, var. *crotonis*. Douglas.

J. W. Douglas. *Entomologist's Monthly Magazine*, April 1887, p. 241.

This variety described from Regents Park, London, occurs also at Kew (Newstead), and Mr. Cockerell records it from Jamaica and Antigua, on croton. It is probably introduced and does not seem to occur at the present time.

In addition to the above species Mr. Cockerell records two from Jamaica:—

(26) *Parlatoria proteus.* Curt.
V. Signoret, *Essai*, p. 132.

(27) *P. Pergandei.* Comst.

J. H. Comstock, *Report U. S. Department of Agriculture*, p. 327.

PSEUDOPARLATORIA.

(28) *Pseudoparlatoria ostreata.* Ckll.
Journal Institute Jamaica, I, p. 136.
Recorded from Jamaica (Ckll.)

DIASPIS.

17. (29) *Diaspis* (Aulacaspis) *Boisduvalii.* V. Signoret.

V. Signoret, *Essai*, p. 114.
(*Aulacaspis tentaculatus.* A. C. F. Morgan, *Entomologist's Monthly Magazine*, 1893, p. 41.)

This species, described from the green-houses at the Luxembourg, is a common green-house pest in England (Newstead)

and Canada (King), it lives in the open air in the Sandwich Islands (Newstead), and Mexico (Ckll.), and has been found in Jamaica, Trinidad and Barbados (Ckll.). It is now plentiful in Barbados on the cocoa-nut palm, living in little dense colonies on the under side of the leaves. Its original home is uncertain, and it has probably been introduced to the West Indies.

Male scales are abundant.

18. (30) var. *maculata*. Ckll.

T. D. A. Cockerell. *Mais Algumas Coccidas. Revista do Museu Paulista*, 1898.

Described by Mr. Cockerell from Campinas, Brazil. Also found on pine-apple in Antigua and Dominica.

The female puparium is quite distinct from that of *A. boisduvalii* as found in the West Indies, but the characters of the pygidium and the presence of the thoracic tubercle place this variety nearer to *A. boisduvalii* than to the form it also resembles, *D. bromeliae*.

The female puparium is light straw-colour, with a darker central spot formed by the exuviæ. Males abundant.

19. (31) *Diaspis calyptroides*. Costa.

V. Signoret, *Essai*, p. 116.

(*D. opunticola*. Newst.)

An apparently neotropical species, recorded by Signoret probably from Mexico, since found in Algeria, South Europe, Demerara (Newst.), New Mexico, Arizona and India (Ckll.). It was found in Barbados on *Melocactus communis* (the Turks head cactus) imported from Antigua, and was probably introduced to that island. In the Antigua specimens, the female puparia were of a light brown colour: the scales of both sexes covered the plants with a dense coating, almost obscuring its original colour.

(32) var. *opuntiae*. Ckll.

T. D. A. Cockerell, *Journal Institute Jamaica*, Vol. I., p. 256.

In Jamaica (Ckll.) and Porto Rico (Busck).

AULACASPIS.

20. (33) *Aulacaspis* (Diaspis) *pentagona*. Targ-Tozz.

R. Newstead, *Coccidae of the British Isles*, I, p. 173.

(*Diaspis amygdali*. Tryon. *D. lanatus*. Ckll.)

A cosmopolitan species, recorded from every continent. Among the localities are Cape Colony, Hong Kong, Ceylon Japan, Brazil, South Europe, Australia, United States, Fiji, Great Britain.

In the West Indies it is found in Jamaica (Ckll.), Porto Rico (Busck), Trinidad (Urich), Martinique and Grand Cayman (Howard), Barbados and San Domingo (Riley). In the smaller islands it is now known from Grenada, St. Vincent, Barbados, Dominica, and Antigua.

Dr. L. O. Howard regarded it as originating from the West Indies; this view is confirmed by the fact that it is one of the few species found on wild plants far from cultivation. I have found it in Dominica on a forest tree at an altitude of over 2,000 feet, and it occurs on *Bryophyllum calycinum* which grows wild plentifully in waste places in Barbados. Its origin has recently been ascribed to Japan and there would appear to be evidence in support of this view; but it has so strong an appearance of being a native that I regard it as such at the present time.

Its food plants are very various; it habitually attacks the capsicum, papaw (*Carica*) and castor oil plant (*Ricinus*) and is found on Central American rubber (*Castilloa*), the Immortel (*Erythrina*), *Odontadenia*, and mulberry.

Scales of both sexes form a densely packed covering on the twigs, branches, and stems of the food plants.

21. (34) *Aulacaspis* (Diaspis) *rosae*. Bouché.

V. Signoret, *Essai*, p. 123.

An introduced species, found on wild roses in England (Newstead), in Florida, California and the Northern United States (Comstock), in Harvard, Mass., and in Canada (King). Mr. Cockerell records it from Jamaica and it now occurs in Barbados. In the latter locality it infests mango alone, and I have found it in only one spot.

The aspect of the colonies is striking, one or more female scales with a considerable number of male scales being grouped together. It occurs only on the leaves and fruit, and at a distance the leaves appear to have large white spots on them.

CHIONASPIS.

22. (35) *Chionaspis* (Howardia) *biclavis*. Comst.

J. H. Comstock, *Second Report on Scale Insects*, 1893, p. 98.

A species of doubtful origin, known from the United States (Comstock), Ceylon (Green), Sandwich Islands (Koebele), and Kew (Newstead).

It has doubtless been spread on cultivated plants, and has probably been introduced to the West Indian islands. Mr. Busck found it in Porto Rico, Mr. Cockerell records it from Trinidad, and it now occurs in Barbados, Montserrat, Antigua, and St. Kitt's. Its habit of burrowing below the outer layer of the bark renders it inconspicuous; as a rule it infests only *Tabernaemontana coronaria*, but in Antigua it also

attacked *Acalypha*, *Hibiscus*, *Croton discolor*, and other plants. Male scales do not appear to occur here.

23. (36) *Chionaspis citri.* Comst.

J. H. Comstock, *Second Report on Scale Insects*, 1883.

Almost wholly neotropical in distribution, found elsewhere in New Zealand, Australia and Tonga (Mask.). It is recorded in Louisiana and Cuba (Comst.), Bermuda (King), Porto Rico (Busck), Havana, Mexico and Demerara (Ckll.). Mr. Cockerell received it from Trinidad and Antigua but does not appear to have found it in Jamaica. Mr. E. S. Panton has recently sent me this species from Jamaica and it is tempting to believe that it was introduced to Jamaica since Mr. Cockerell was there. It occurs also in all the smaller islands except Nevis and St. Kitt's.

All varieties of citrus are attacked by this species, and so far I have seen it on no other plant.

The male scales cover the bark of the trunk and branches, giving a whitewashed appearance, and examination reveals also the grey female scales, which are less numerous.

24. (37) *Chionaspis minor.* Mask.

W. M. Maskell, *Coccidae of New Zealand*, p. 56.

Originally described from New Zealand, since found in Mexico and Brazil (Ckll.), Panama and Florida (Cooley), Porto Rico (Busck). Mr. Cockerell records it from Grand Cayman, Jamaica, Trinidad, Grenada and Antigua ; it is now abundant in all the smaller islands on a variety of plants including the pigeon pea (*Cajanus*), hibiscus, oleander, lilac (*Melia Azedarach*). *Murraya exotica*, Barbados flower fence (*Caesalpinia pulcherrima*), castor oil, cotton and saman (*Pithecolobium Saman*.) It usually forms a dense incrustation on the stems of its food plants.

Mr. Cooley describes a variety, *strachani*, from West Africa (*Bulletin Massachusetts Agricultural College, Aug. 1899*), differing from the typical form in the darker exuviae of the puparium and the larger more obtuse median lobes of the pygidium, which are also more finely crenate. These characters occur in some West Indian specimens, with a deeper colour of the puparium of the female, but they are so connected with the typical form by intermediates that it is not possible to separate them sharply : they vary also in the relative development of the lateral lobes and so are linked to Mr. Cockerell's *C. major*, which is however a well-marked form.

In addition to the above species, Mr. Cockerell records :—

25. (38) *Chionaspis major.* Ckll.

T. D. A. Cockerell, *Canadian Entomologist*, 1884, p. 197.

Described from specimens found in Antigua on heliotrope

by Mr C. A. Barber. It is not a common species and I have not been able to find it there or elsewhere in the West Indies.

(39) *C. aspidistrae.* Sign. (*C. braziliensis*) from Trinidad.

V. Signoret, *Essai*, p. 125.

MYTILASPIS.

26. (40) *Mytilaspis citricola.* Pack.

J. H. Comstock, *Report U. S. Department of Agriculture*, 1880, p. 321.

(*M. becki* (Newman) Ckll)

(*M. pinnaeformis* (Bouche) Newst.)

Found probably wherever citrus occurs: it is recorded from Fiji (Mask), New Zealand, Australia, Madeira, (Green), Italy, Spain, Azores (Sign.), Kew, (Douglas), Louisiana. Florida, Bermuda (Comst.), Para, Russia, New South Wales, Tahiti (Ckll.), and from Surinam. It is known throughout the West Indies.

Its origin is doubtful, but Mr. Comstock looked on it as of European origin. In the West Indies it has the characters of an introduced species. Its food plants are citrus of all kinds and *Murraya exotica.* Though a very common pest of those plants, I have never seen it on any other. Scales of both sexes occur together.

27. (41) *Mytilaspis Gloveri.* Pack.

J. H. Comstock, *Report U. S. Department of Agriculture*, 1880, p 323.

A widely distributed species, though less common than *M. citricola* which it so closely resembles It is recorded from Australia(Mask), Louisiana. Florida.China. South Europe(Comst.) Ceylon (Green), Mexico (Ckll.). It has been found in Montserrat on lime (D. W. Coquillet) and a possible variety of it occurs now in Barbados and Antigua on croton. Mr. Maskell doubted whether this was distinct from *M. citricola*, but Mr. Green treats them as distinct, saying: 'This species may be distinguished from the *citricola* by the narrower and straighter puparium of the female, by the median longitudinal division in the ventral scale, and by the arrangement of the eggs beneath the scale.' He also gives the elongated mesothorax as a character, and the smaller number (two to three) of marginal spines on the abdominal segments, *citricola* having from four to five. Barbados specimens, identified by Messrs. Marlatt and Pergande, have the female puparium wider posteriorly than those figured by Mr. Green, and, but for the arrangement of eggs, do not appear to me to be valid as a variety of *M. citricola.*

In addition to the above species, Mr. Cockerell records:—

(42) *Mytilaspis crotonis.* Ckll.

T. D. A. Cockerell, *Entomologist's Monthly Magazine*, July 1893.

Described from Jamaica.

(43) *Mytilaspis albus.* Ckll.

T. D. A. Cockerell, *Entomologist's Monthly Magazine*, July 1893

Described from Jamaica.

PINNASPIS.

28. (44) *Pinnaspis buxi.* Bouché

Mytilaspis buxi. Signoret, *Essai*, p. 137.

Mytilaspis pandani. Comst., *Report U. S. Department of Agriculture*, 1880, p. 324.

Pinnaspis pandani. Ckll., *Journal Institute Jamaica*, 1892, p. 136.

Common to Europe and the United States, also abundant in the West Indies. Its origin is doubtful, and it would appear to have been introduced to these islands. It has been recorded from Jamaica, Trinidad, Grenada, and Barbados (Ckll.) and is now plentiful also in Dominica, Montserrat and Antigua.

Its food plants here are varied: *Areca*, *Anthurium*, *Epipremnum*, *Dracaena*, *Monstera*, *Spathiphyllum*, and other cultivated ornamental plants, many of which are selected plants common in hot-houses in Europe.

Frequently the scales occur on both sides of the leaf, those on the upper side being nearly white whilst those below remain of the usual brown colour. These light ones may be Mr. Cockerell's white variety, *alba*, described from Trinidad.

(45) var. *alba.* Ckll. found in Trinidad.

T. D. A. Cockerell, *Journal Trinidad Field Naturalist's Club*, Vol. I., p. 307, (1894).

Mr. Cockerell also records:—

(46) *Pinnaspis bambusae.* Ckll.

T. D. A. Cockerell, *Entomologist's Monthly Magazine*, July 1893.

Described from Jamaica.

ISCHNASPIS.

29. (47) *Ischnaspis filiformis.* Sign.

J. W. Douglas, *Entomologist's Monthly Magazine*, 1887, p. 21.

This species is known from Brazil, West Africa and Great

Britain (Newstead), Australia, Japan, United States (Ckll) and Demerara (Dougl.).

It is abundant in the West Indies: Mr. Busck has it in Porto Rico, Mr. Cockerell records it from Jamaica, Trinidad, Antigua and Grenada: it is now plentiful in all the smaller islands but Montserrat, infesting palms, Liberian coffee, *Eranthemum*, *Jasminum*, mango and other plants. It is a continual pest to palms, though I have never found it on either *Cocos* or *Oreodoxa*, the most abundant palms here. It has the characters of an introduced species though its origin is doubtful.

CONCHASPIS.

30. (48) *Conchaspis angraeci.* Ckll.

T. D. A. Cockerell, *Journal Institute Jamaica*, Vol. I, p. 256. (1893).

Pseudinglisia rodrigueziae. Newst. *Entomologist's Monthly Magazine*, July, 1893 p. 153.

Recorded by Mr. Newstead and Mr. Cockerell from Trinidad and Jamaica and since found on an imported *Epidendrum ciliare* in Barbados.

PULVINARIA.

31. (49) *Pulvinaria ficus.* Hempel.

A. Hempel. *Annals & Magazine Natural History*, Aug. 1901, p. 100.

This species was described by Mr. Hempel from Brazil, the species being formerly confused with *P. psidii*, Mask. My West Indian specimens, determined as *P. psidii*, seem to be clearly referable to *P. ficus*.

The species is found in Barbados, Montserrat, Antigua and St. Kitt's, on the akee (*Blighia*), Liberian coffee and guava. The fact that it is found on wild plants in many scattered localities points to this species as a native of these islands.

32. (50) *Pulvinaria simulans.* Ckll.

T. D. A. Cockerell, *Journal Trinidad Field Naturalist's Club*, 1894, p. 310.

A West Indian species, described from Trinidad, since found in Barbados on a Genip tree. (*Genipa americana*).

33. (51) *Pulvinaria urbicola.* Ckll.

T. D. A. Cockerell, *Transactions Entomological Society, London*, 1893, p. 160.

Described from Jamaica, since found in Barbados.

It is not uncommon on the capsicum, sweet potato, and *Alternanthera*, infesting both the roots and stems.

It is apparently a native of these islands.

The above three species of *Pulvinaria* are not easy to distinguish and I have here tabulated the characters that mark my specimens, to show the minuteness of the differences between them.

	P. FICUS.	P. SIMULANS.	P. URBICOLA.
Colour before oviposition	light green.	deep brown.	green, brown pattern.
Colour after oviposition	green.	deep brown.	green, reddish brown pattern.
Ovisac	loose, fluffy.	firm, parallel sides, two grooves.	soft, parallel sides, no grooves.
Dermis	reticulate antero laterally.	simple.	simple.
Marginal hairs	numerous, bent tips, broadly divided.	sparse, tips tri-fid.	numerous, some divided irregularly.
Hairs on anal lobes	one at dorsal apex.	three, dorsal.	four, dorsal.
Antenna			
Joint 1	4	5	5
„ *2*	5	7	7
„ *3*	11	10	9
„ *4*	6	5	5
„ *5*	5	5	6
„ *6*	4	4	4
„ *7*	3	3	4
„ *8*	5	6	7
Formula	3.4. [2.5.8.] [1.6.] 7.	3.2.8 [1.4 5.] 6.7.	3.[2.8] 5.[1.4] [6.7.]
Leg. Femur	28	23	24
Tibia	29	22	23
Tarsus	13	14	13

Whilst a careful examination of fresh specimens in which the ovisac is perfect will distinguish these species in many cases, there are otherwise no good characters; the measurements of the antennae are from a series of at least six specimens in each case (multiply by 6·7 to get them in micro millimetres): other characters appear to be of no value and are not tabulated.

Possibly a study of specimens of this genus from all parts

of the world may put the discrimination of species of *Pulvinaria* on a better basis; the antennae vary so greatly and the characters of the ovisac are so dependant on the plant on which the specimens are found, that they would not appear to have much value for discriminating closely allied species.

In addition to the above three species, Mr. Cockerell has described the following:—

(52) *P. brassiae.* Ckll., in Trinidad.
—*Canadian Entomologist*, 1895, p. 135.

This may be identical with *P. floccifera* Westwood (Ckll. in litt.)

(53) *P. Broadwayi.* Ckll., in Grenada.
—*Journal Trinidad Field Naturalist's Club*, Vol. II, p. 306.

(54) *P. cupaniae.* Ckll., in Jamaica.
—*Transactions Entomological Society, London*, 1893 p. 159.—

(55) *P. dendrophthorae.* Ckll., in Jamaica.
—*Transactions Entomological Society, London*, 1893. p. 159.—

PROTOPULVINARIA.

34. (56) *Protopulvinaria pyriformis.* Ckll.

T. D. A. Cockerell, *Journal Trinidad Field Naturalist's Club*, Vol. I., p. 309: (1894).

(*Pulvinaria Newsteadi.* Leonardi.)

Apparently confined to the West Indies; it is recorded by Mr. Cockerell from Trinidad, Jamaica and Grenada. It is now plentiful in St. Vincent, Barbados and Dominica.

Its food plants are very varied, comprising:— Cinnamon, citrus, *Cordia*, Java plum (*Eugenia*), *Lawsonia*, *Malpighia*, *Melia Azedarach*, Avocado pear (*Persea*), frangipani (*Plumeria*) and guava.

This species is very similar to *Lecanium mangiferae*, Green, which is also abundant and cannot easily be distinguished unless fully mature. The formation of a white ovi-sac under the female and its reddish colour when mature distinguish this *Protopulvinaria* from the flatter green or brown *Lecanium mangiferae* which forms no ovi-sac and is practically ovo-viviparous. The characters of the antennae, marginal hairs and anal scales are very closely similar in the two species.

INGLISIA.

35. (57) *Inglisia vitrea.* Ckll.

T. D. A. Cockerell, *Journal Trinidad Field Naturalist's Club*, 1894, p. 308.

Described from Trinidad and apparently confined to that island.

VINSONIA.

36. (58) *Vinsonia stellifera.* Westwood.

V. Signoret, *Essai*, p. 190.

J. W. Douglas, *Entomological Monthly Magazine*, December 1888.

A species of doubtful origin, recorded from Réunion (Sign.), Ceylon (Green), Para (Ckll.). It occurs throughout these islands on the following plants :— Sapodilla (*Achras*), cashew (*Anacardium*), *Allamanda*, star-apple (*Chrysophyllum*), cocoa-nut and other palms, *Epidendrum* and other orchids, Java plum (*Eugenia*), *Ixora*, mango and many other plants.

It would appear to be introduced. No males are known to occur here.

CEROPLASTES.

37. (59) *Ceroplastes cirripediformis.* Comst.

J. H. Comstock, *Report United States Department of Agriculture*, 1880, p. 333.

This species was described from Florida and has been found in Jamaica and Antigua (Ckll.). It occurs also in Barbados on star-apple, *Chrysophyllum*, seaside grape (*Coccoloba*) and *Justicia*, and I have recently found it on *Cordia* in Antigua and in St. Lucia. It is a rare species here, never abundant and of slow growth.

What is probably a variety of the above was described from Antigua by Mr. Cockerell as *C. plumbaginis*.

38. (60) var. *Plumbaginis*. Ckll. in Antigua.

T. D. A. Cockerell, *Entomologist*, 1893, p. 82.

39. (61) *Ceroplastes Dugesii.* Licht.

Bull. Soc. Ent. France, p. cxli. (1885).

This has been confused with *C. ceriferus*. Anders. and recorded under that name from Antigua (Ckll.). Mr. Cockerell has pointed out that whereas *C. ceriferus* has six-jointed antennae, *C. dugesii* has them seven-jointed and he places

the Antigua specimens found by Mr. Barber in the latter species. Specimens obtained in Barbados agree with those in Mr. Barber's collection. It occurs only on *Bursera gummifera* and is the largest *Ceroplastes* yet found in these islands. The wax is very thick with an aromatic odour and it is partially soluble in chloroform and other liquids. Mr. Cockerell records this species in Mexico.

40. (62) *Ceroplastes denudatus.* Ckll.

T. D. A. Cockerell, *The Entomologist*, Vol. xxvi, p. 82. (1893).

Described from Antigua on soursop (*Anona*) and since found in Demerara. It occurs also on the soursop in Grenada, infesting the leaves and fruit. The wax is thin and soft and appears to disappear naturally as the insect matures.

41. (63) *Ceroplastes Floridensis.* Comst.

J. H. Comstock, *Report United States Department of Agriculture*, 1880, p. 331.

A Florida species, also found in Ceylon (Green). Mr. Busck found it in Porto Rico and Mr. Cockerell found it in Jamaica. It is now abundant in all the smaller islands.

Its food plants comprise lime, *Ixora*, *Lawsonia*, *Malpighia*, mango, tea, *Triplaris* and some others.

It forms the most abundant *Ceroplastes* in the smaller islands though it never appears to become sufficiently numerous to injure its food plants.

In addition to the above species, the following are also recorded by Mr. Cockerell:—

(64) *C. albolineatus.* Ckll., in Jamaica.
—*Entomological News*, 1894, p. 157.

(65) *C. confluens.* Ckll. & Tinsley, in Jamaica.
—*Journal Institute Jamaica*, Vol. II., p. 468.

(66) *C. depressus.* Ckll., in Jamaica.
—*Entomologist*, 1893, p. 17.

(67) *C. euphorbiae.* Ckll., in Jamaica.
—*Psyche*, Supplement, 1896, p. 17.

(68) *C. jamaicensis.* White, in Jamaica.
—V. Signoret, *Essai*, p. 201.

(69) *C. utilis.* Ckll., in Grand Turk Island.
—*Entomologist*, 1893. p. 81.

LECANIUM.

42. (70) *Lecanium depressum.* Sign.

V. Signoret, *Essai*, p. 269.

This appears to be confused with *L. nigrum*, Nietn. and I am adhering to the distinction made by Mr. G. B. King (*Psyche*, January 1902, p. 296.) between the two species. His *L.* (*Saissetia*) *nigrum* is undoubtedly Mr. Cockerell's *L. depressum*, dealt with here under *L. nigrum.* What Mr. King regards as *L. depressum* I find only on *Coleus* and *Furcraea cubensis* in Barbados.

It is oval in outline, inclining to pyriform, relatively broader than *L. nigrum*, less convex, and of a reddish-brown colour when mature. I can find no difference in the tesselation, nor in the characters of the anal scales, antennae, etc., and regard my specimens as constituting a well marked form —and color— variety of Nietner's *L. nigrum.*

43. (71). *Lecanium hemisphaericum* Targ-Tozz.

V. Signoret, *Essai*, p. 266.

(*L. coffeae.* Walk. *L. filicum.* Boisd.)

A widely distributed species, recorded from Bahia and Europe (Signoret), California and Washington (Comst.), Ceylon (Nietner), Australia (Mask.), Kew (Green), Harvard, Mass. (King) and Para (Ckll.).

In the warmer parts of the world it lives in the open air, in other latitudes in green-houses. Mr. Cockerell records it from Tasmania, Trinidad and Antigua, Mr. Busck from Porto Rico and it is now abundant throughout the smaller islands. There are several described varieties :—

var. *hibernaculorum* a valid variety.

var. *coffeae* on coffee would appear to be not even a valid variety.

var. *filicum*, on ferns, is regarded by Mr. Cockerell as distinct and near to *L. clypeatum* ; Mr. King treats this as a distinct species, and has kindly sent me specimens ; but as I cannot find any specimens among my material that differ from the typical form sufficiently to be even a variety, I conclude either *L. filicum* is not West Indian or is an extreme form of *L. hemisphaericum.* *L. hemisphaericum* lives on a large variety of plants including sugar-apple (*Anona*), *Allamanda*, *Barleria*, citrus, *Cycas*, *Eranthemum*, *Glycosmis*, *Graptophyllum*, *Ixora*, *Justicia* *Monstera*, Avocado pear (*Persea*), frangipani (*Plumeria*), guava, hogplum (*Spondias*), *Thunbergia*, and many others. It infests leaves and twigs.

Its young have the ridges on the dorsum which occur in *L. oleae* only losing them as they mature, and it is easy to confuse the two. The simplest character for discrimination lies in the tesselation and in the character of the anal scales.

This species can probably be regarded as introduced to the West Indies. It has become very abundant and increases with great rapidity, the large number of eggs produced by one female being apparently enough to allow for the large amount of destruction from parasites, egg-destroying *Diplosis* larvae, ladybird beetles, phycitid caterpillars, and fungoid disease.

(72) var. *hibernaculorum*. Bdv.

Ent. Hort. p. 337. (1867).

Described from Jamaica.

44. (73) *Lecanium hesperidum*. L.

V. Signoret, *Essai*, p. 229.

A widely distributed species, recorded from the United States (Comst.), New Zealand and Australia (Mask.), Canada (King), and Kew (Green). Mr. Cockerell found it in Jamaica, where it appears to have been as scarce as it is now abundant in Grenada, St. Vincent, Barbados, St. Lucia, Montserrat, Antigua, and St. Kitt's.

Its food plants include sapodilla (*Achras*), *Allamanda*, chrysanthemum, star-apple, *Chrysophyllum*, citrus, coffee, *Cordia*, *Ixora*, *Lawsonia*, frangipani (*Plumeria*) and guava.

It varies in colour, apparently according to its food plants. On citrus, *Cordia* and some others, it is green, with few black markings and very closely resembles *L. viride*. On the Allamanda, star-apple and guava it is light brown, and may become deep reddish brown.

It is possibly not distinct from *L. viride*, and Mr. Maskell considered it might be synonymous with *L. lauri*.

45. (74) *Lecanium longulum*. Dougl.

J. W. Douglas, *Entomologist's Monthly Magazine*, 1887, p. 97.

L. Chirimoliae. Mask., *Transactions New Zealand Institute*, xxii, p. 137.

A widely distributed species, of somewhat rare occurrence. It is known from Fiji and the Sandwich Islands (Mask.), from Massachusetts hot-houses (King) and from Kew and Ceylon (Green). Mr. Cockerell received it from Antigua and Jamaica, and it now occurs in Barbados and Grenada on sugar-apple (*Anona*) and the sandbox.

It is a retiring species, closely resembling in colour the stem or branch it may be on, so closely pressed down as to escape observation.

A small variety, similar in all but size to the normal form, occurs in Barbados on *Leucaena* and some other plants. Possibly this reduction in size has followed from the small twigs it is generally found on, but specimens that attach themselves to larger branches or stems remain equally small.

I am indebted to Mr. G. B. King for comparing these small specimens with the normal forms in his own collection.

46. (75) *Lecanium mangiferae.* Green.

This species, described from Ceylon, is probably introduced to the West Indies. Mr. Cockerell records it from Jamaica and Trinidad and it occurs now in all of the smaller islands.

Its habitual food-plants include mango, breadfruit, Java plum (*Eugenia*), and nutmeg ; there are also very many occasional food-plants.

Its close resemblance to *Protopulvinaria pyriformis* has been mentioned above.

47. (76) *Lecanium nigrum.* Nietner.

J. W. Douglas, *Entomologist's Monthly Magazine*, April, 1891.

Described from Ceylon, also recorded from Kew (Green), Porto Rico (Busck), and Para (Ckll.). It is possibly recorded from many other localities under *L. depressum* under which Mr. Cockerell referred to it in writing on West Indian *Coccidae* It is now found in Grenada, Barbados, St. Kitt's, St. Lucia, Dominica, Antigua, on sandbox (*Hura*), Hibiscus, *Anona* spp , *Ficus laurifolia*, cotton, manchineel. *Melia Azedarach*, etc.

48. (77) *Lecanium oleae.* Bern.

V. Signoret, *Essai*, p. 271.

A widely distributed species found in Southern Europe (Signoret,) California and Florida (Comst.). Massachusetts, (King), Kew (Green), and Porto Rico (Busck). Mr. Cockerell records it in Jamaica and Trinidad, and it is now found throughout the smaller islands, on a large variety of occasional food-plants and the following habitual ones:—

Fig, citrus, *Lawsonia*, guava, hogplum (*Spondias*) and *Thunbergia*.

It is probably an introduced species ; males occur rarely.

49. (78) *Lecanium punctatum.* Ckll.

T. D. A. Cockerell, *Journal Trinidad Field Naturalist's Club*, Vol. II, p. 194.

Apparently peculiar to Grenada, found there on citrus in the Botanic Station. It still occurs in small numbers on the branches of the lemon and suffers from the attack of a small caterpillar, probably one of the *Phycitinae*.

50. (79) *L. tesselatum.* Sign.

V. Signoret, *Essai*, p. 231.

This species, described from Southern Europe, has been found also at Sydney (Mask.), Harvard, Mass. (King), Ceylon (Green).

Mr. Cockerell has it in Jamaica on Lignum-vitae and it now occurs in Grenada and Barbados on *Caryota urens*, *Calophyllum* and *Melaleuca*. On *Caryota* it is common, as it is also in Ceylon and Southern Europe, and it may very probably have been spread on this palm.

(80) var. *Swainsonae*. Ckll.

T. D. A. Cockerell, *Jamaica Bulletin*, 1897, p. 109.

Described from Jamaica.

In addition to the above the following are recorded by Mr. Cockerell :—

51. (81) *L. assimile*, var. *amaryllidis*. Ckll. from Antigua. It is probably not related to *L. assimile* (Ckll. in litt.) *Transactions American Entomological Society*, 1893, p. 53.

52. (82) *L. batatae*. Ckll. found on sweet potato in Antigua by Mr. Barber.
Annals & Magazine Natural History, 1895, p. 61.

53. (83) *L. begoniae*. Dougl., a possible variety of *L. nigrum*, described from British Guiana and found in Antigua by Mr. Barber (Ckll.).

J. W. Douglas, *Entomologist's Monthly Magazine*, Aug. 1896.

(84) *L. nanum*. Ckll., from Trinidad.

Trinidad Bulletin, April 1896.

(85) *L. rubellum*. Ckll., in Jamaica.

Journal Institute Jamaica, I, p. 378.

(86) *L. terminaliae*. Ckll., in Jamaica.

Journal Institute Jamaica, I., p. 254.

54. (87) *L Urichi*. Ckll., in Trinidad, found by Mr. Urich, also recorded from Grenada and Brazil (Ckll.).

Journal Trinidad Field Naturalist's Club, II, p. 219.

DACTYLOPIUS.

55. (88) *Dactylopius adonidum*. Auctt.
V. Signoret, *Essai*, p. 340.

D. longifilis. Comst. *Report United States Department of Agriculture*, 1880, p. 344.
D. longispinus.

A common green-house pest in temperate latitudes, recorded from New Zealand (Mask.), United States (Comst.), Kew (Green), as also from Mysore (Atkinson) and Ceylon (Green) in the open air.

Mr. Cockerell records it from Jamaica, and it is now present in St. Vincent, Barbados, St. Lucia, Dominica and Antigua.

It generally occurs on ferns and plants grown under shade, but in Dominica, Barbados, and St. Lucia it lives in the open and is abundant in the latter island at Castries, where it lives on croton, vanilla, *Dracaena* and other plants.

It is apparently an introduced species, which appears to increase rapidly in the open air. Males are rare, the majority of the insects being females.

56. (89) *Dactylopius brevipes.* Ckll.

T. D. A. Cockerell, *The Entomologist*, 1893, p. 267.

A West Indian species, described from Jamaica, also occurring in Antigua and Dominica.

It lives on the pine-apple and has a habit of entering the flowers, remaining there till the flower withers and the 'bracts' close the 'eye' enclosing the insects.

Mr. Cockerell characterises it as 'a small pink species with filaments along the side like *D. adonidum* but without any tails' (*Jamaica Bulletin*, August 1893, p. 3.). He separates it from *D. citri* by its colour (the latter being pale brownish), as well as its small size, and the shortness of the legs; in my specimens there is a slight difference in the relative length of the joints of the antennae.

It is very similar to *D. citri*, and not at all easy to distinguish. *D. citri* is also found on the pine in Antigua but never enters the 'eye.' Possibly this species is a variety only, developed from *D. citri* on the pine.

57 (90) *Dactylopius calceolariae.* Mask.

W. M. Maskell, *Coccidae of New Zealand*, p. 100.

Found by Mr. Maskell on various plants in New Zealand and on sugar-cane from Fiji. Since recorded by Mr. Cockerell from Jamaica. It occurs abundantly in Barbados, living under the sheathing leaves, high up on the canes. The large pink insects can be seen on the canes, often surrounded by cottony masses containing eggs. It is difficult to imagine how this insect persists from one season to another, unless it is planted with the pieces of cane, under the sheathing leaves. It is not common on the young canes, but becomes abundant as they attain their full growth.

58. (91) *Dactylopius citri.* Boisd.

V. Signoret, *Essai*, p. 346.

D. destructor. Comst., *Report United States Department of Agriculture*, 1880, p. 342.

A probable European species found on citrus in Southern Europe (Sign.) in green-houses in the United States, on citrus in Florida (Comst.), and also in Kew (Green).

It is found in Jamaica and Trinidad (Ckll.), as also in Grenada, St. Vincent, Barbados, Dominica, Montserrat and Antigua.

Its habitual food plants include croton, cacao, breadfruit and *Morinda*, and I have once found it on lime. (*Citrus medica*, var. *acida*).

The males are very scarce, and this species is parthenogenetic as a rule.

59. (92) *Dactylopius dubia.* Newst.

?=*D. nipae.* Mask.

Specimens referred to this species were found on cocoa-nut palm in Barbados and Grenada Mr. Cockerell informs me this species is a synonym for *D. nipae.* Mask., but I have preferred to record the fact that a Coccid with distinct points of difference from our specimens of *D. nipae* does occur, and as it has been determined as *D. dubia*, I here record its occurrence.

60. (93) *Dactylopius nipae.* Mask.

W. M. Maskell, *Further Coccid Notes*, 1892, p. 178.

Described from Demerara specimens, and since recorded from Harvard, Mass. (King). It has been found in Trinidad (Ckll.) and also on a *Phoenix acaulis* in Barbados which had been imported.

61. (94) *Dactylopius sacchari.* Ckll.

T. D. A. Cockerell, *Journal Trinidad Field Naturalist's Club*, Vol. II, p. 195

Described from Trinidad on sugar-cane and found in Porto Rico by Mr. Busck. A similar species occurs in Barbados having one point of difference from the Trinidad specimens: the latter are described as having seven-jointed antennae, which appear six-jointed owing to the lack of division between joints 2 and 3. Barbados specimens have this character, but joint 3 may also have a division, making the antennae eight-jointed. In all other respects they agree.

Both this species and *D. calceolariae* occur together on the canes in Barbados but they may be known by their colour (olivaceous or pinkish), their shape (cylindrical or pyriform). length of leg (short or long), and by the antennal formula,

There are also differences in the appearance of the waxy covering and filaments, but as ants usually strip both species quite bare, this character is only available when the insects can be kept a few days in captivity.

62. (95) *Dactylopius virgatus.* Ckll.

T. D. A. Cockerell, *The Entomologist*, 1893, p. 178.

(*D. ceriferus.* Newst.)

Described from Jamaica and now known from Barbados and Montserrat. Mr. Newstead's *D. ceriferus* was found in Madras.

The behaviour of this insect in Barbados has been of special interest. In two successive years it has appeared in enormous numbers in a garden which is under constant observation. The attack became evident each year in June, and in a short time large masses of this insect were found in the leaves, branches and trunk of a number of trees. It then spread to other trees in the neighbourhood. One tree was cut back to almost a stump and very vigorous spraying with a hot wash saved the others. The insect then disappeared and during the remainder of the year does not appear to have occurred there, the whole of the grounds being under observation. It has also been found throughout a field of woolly pyrol (*Mucuna*). Every plant was slightly infested although this crop had only been growing a few weeks and in this case the insect was found to have probably come from the roots of weeds growing in and near this field.

The insect increases with great rapidity. No male insects have been found; the very large females produce large numbers of eggs, which hatch almost immediately and develop very rapidly. Its food plants include croton (*Codiaeum*), capsicum and frangipani (*Plumeria*), but it is not as yet possible to characterise any habitual food plants.

(96.) var. *farinosus.* Ckll.

T. D. A. Cockerell. *The Entomologist*, xxvi., p. 179. (1893). Found in Trinidad.

In addition to the above species, Mr. Cockerell records the following:—

(97) *D. filamentosus.* Ckll. from South Caicos Island. —*The Entomologist*, 1893, p. 268.

(98) *D. segregatus.* Ckll. from Jamaica. —*Journal Institute Jamaica*, Vol. I. p. 254.

(99) *D. simplex.* Ckll. from Jamaica. —*The Entomologist*, 1893, p. 267.

RIPERSIA.

(100) *Ripersia serrata.* Tinsley, from Trinidad.

—*Canadian Entomologist*, 1900, p. 66.

CEROPUTO.

63. (101) *Ceroputo Barberi.* Ckll.

Phenacoccus yuccae, var. *barberi.* Ckll. *Annals & Magazine Natural History*, 1895, p. 61.--*Bulletin U.S. Department of Agriculture, Division of Entomology, Technical Series*, 4 p. 39.—

Described from Mr. Barber's specimens from Antigua and St. Kitt's, found also in Trinidad (Ckll.) A species closely similar to this is found in Grenada and Montserrat on citrus and a slightly different variety in St. Lucia on *Dracaena.* Further study is needed before these can be placed accurately with respect to Mr. Cockerell's species, but they appear likely to prove to be local varieties, not specifically distinct.

(102) *Phenacoccus helianthi*, var. *gossypii.* Twns. and Ckll.

C. H. T. Townsend and T. D. A. Cockerell. *Journal New York Entomological Society*, vi., p. 170.
in Porto Rico (Busck).

PSEUDOCOCCUS.

64. (103) *Pseudococcus Tomentosus Newsteadi.* Ckll.

This species was found on a single plant of *Opuntia* in Antigua in May 1901. It was sent to Mr. Cockerell, who referred it to *P. Newsteadi.* Ckll. (*tomentosus.* Newst. *Entomologist's Monthly Magazine*, 1897, p. 75)

I quote the following table from Mr. Cockerell's letter :—

The forms of Pseudococcus can be separated thus :—

1. relatively large, with only a mealy covering : dermal truncate spines none or few......*signoreti.* Ckll. (=*cacti*, Sign.)
2. smaller, with a dense cottony covering : dermal truncate spines well developed.....................3.

3. over 3 mm long, with a separate cottony sac on each individual, the individuals readily separable, antennae usually seven-jointed ....*opuntiae*, (Licht' Ms.) Ckll.
not over 3 mm long, the cotton irregular, that of several individuals coalescing so that they cannot easily be separated. Antennae usually with not over six joints. ....4.

4. with groups of dermal glands larger, often 50 to 90, truncate spines longer on the average. Lives in Upper Austral Zone in Western North America. ....*confusus*. Ckll.

with groups of dermal glands smaller, rarely over 25, truncate spines shorter and broader on the average. Lower Austral Zone and Tropics. ... . *Newsteadi*. Ckl.

The bibliography is as follows:--

P. signoreti. Ckll. (*cacti* Sign. not Linn.)

Science, 1900, p. 992.

P. opuntiae, (Licht. Ms.) Ckll.

Bulletin U. S. Department of Agriculture, Division of Entomology, Technical Series, 4, p. 35.

P. confusus. Ckll. *American Naturalist*.

P. Newsteadi. Ckll. *Science*, 1900. p. 992.

(*tomentosus*. Newst. *Entomologist's Monthly Magazine*, 1897, p. 75.)

'The Jamaica insect referred to in *Technical Bulletin*, 4, p. 35. *Division of Entomology U. S. Department Agriculture* would also no doubt go with *P. Newsteadi*' (Ckll. Ms.) So that the Antigua species is closely allied to the Jamaica one, and these are the sole West Indian localities known. The Jamaica insect is referred to in the *Jamaica Bulletin*, under *C. cacti* L.

The Antigua species is here named *P. tomentosus Newsteadi*, Ckll. as representing as closely as possible its standing in the light of our present knowledge.

It formed a dense mass of cottony material on the *Opuntia*; large numbers of males emerged, the body, legs and head of a purple red colour with a very slight mealy powdering; the antennae eleven-jointed, slightly hairy; the caudal process ventral and short: caudal spines long and white; wings with very faint veins.

TACHARDIA.

(104) *Tachardia gemmifera*. Ckll. in Jamaica.
Canadian Entomologist, 1893, p. 18.

ASTEROLECANIUM.

65. (105) *Asterolecanium bambusae*. Boisd.
V. Signoret, *Essai*, p. 168.

A possible European or Oriental species, found in Algeria (Boisd.), Ceylon (Green) and Kew (Newst.); it occurs in Jamaica

and Trinidad (Ckll.), Porto Rico (Busck), also in Grenada (Ckll.), St Vincent, Barbados, St. Lucia and Dominica.

It is confined to bamboo, covering all parts of the plants in a dense coating, but does not appear to affect their vitality.

66. (106) var. *bambusulae*. Ckll. Described from Grenada.

T. D. A. Cockerell, *American Naturalist*, Vol. xxxi, p. 590. (1897.)

67. (107) *Asterolecanium pustulans*. Ckll.

T. D. A. Cockerell, *Jamaica Bulletin*, Jan. 1896, p. 8.

Described from Jamaica, since found in Brazil, Florida, Sandwich Islands, Anguilla and Demerara (Ckll.), and Porto Rico (Busck.). It now occurs in Grenada, Barbados, St. Lucia, Dominica, Montserrat and Antigua.

It infests the akee (*Blighia*), oleander, *Bougainvillea*, pigeon pea (*Cajanus*), Central American Rubber (*Castilloa*), stephanotis, hibiscus, etc.

It is a curiously destructive species, a few only being sometimes sufficient to kill a twig or small branch. A small pustule is formed below the insect, suggesting the injection by the insect of some poison which not only leads to the formation of the pustule but also to the speedier death of the infested twig or leaf-stalk.

Apparently this species is a native of this region occurring freely on the wild *Lantana* in Barbados and on the wild *Tamarindus filicifolius* in Antigua.

68. (108) *Asterolecanium Urichi*. Ckll.

T. D. A. Cockerell, *Jamaica Bulletin*, January 1896, p. 9.

Originally found in Trinidad on palms by Mr. Urich, since obtained in Grenada on *Bactris minor*. It does not appear to be known outside these localities.

The following are also recorded by Mr. Cockerell :—

(109) *A. aureum*. Boisd. in Trinidad, and Porto Rico (Busck).

V. Signoret, *Essai*, p 165.

(110) *A. miliaris*. Boisd. in Jamaica and Trinidad.

V. Signoret, *Essai*, p. 169.

(111) *A. epidendri*. Bouche. in Jamaica and Trinidad.

(*A. oncidii*, Ckll.)

T. D. A. Cockerell, *Science Gossip*, 1893, p. 78.

(112) *A. palmae.* Ckll. in Jamaica

Science Gossip, 1893, p. 78.

ORTHEZIA.

69. (113) *Orthezia insignis.* Dougl.

J. W. Douglas, *Entomologist's Monthly Magazine*, xxiv, p. 103.
O. nacrea Buckton. *Indian Museum Notes*, iii., p. 103.

A West Indian species, found also in Ceylon, in green houses in the United States (King), and in Cape Colony (Lounsbury). Mr. Cockerell records it from Jamaica, Trinidad and British Guiana, and it now occurs in St, Vincent, Barbados, St. Lucia, Dominica, Antigua and St. Kitt's.

It is rarely found on cultivated plants, preferring wild ones.

In Barbados it is very abundant on the wild *Barleria prionitis*, and has every opportunity of infesting other plants.

Its behaviour here is in curious contrast to its behaviour in Ceylon and elsewhere, where it has proved so destructive to cultivated and wild plants. Far from being destructive here, where *Coccidae* abound on so many plants, it is not easy to obtain specimens of this species.

70. (114) *Orthezia praelonga.* Douglas.

J. W. Douglas, *Entomologist's Monthly Magazine*, September, 1891.

Originally described by Mr. Douglas from specimens received from Trinidad. Has since been found in British Guiana (Douglas), Para, Jamaica and Trinidad (Ckll.). Carriacou, St. Vincent, Barbados, Dominica, Antigua and St. Kitt's.

In Dominica it is found on wild plants; in Antigua a serious pest on lime trees; in Barbados very common on the wild seaside grape (*Coccoloba uvifera*) in all parts of the island; in St. Vincent Barbados, and Trinidad a serious pest of crotons; in Carriacou plentiful on logwood (*Haematoxylon campechianum*), and in Barbados and Antigua common on the wild or cultivated Barbados cherry (*Malpighia*).

It is evidently a native of the West Indies and should if possible be restricted to that province and not allowed to spread as *O. insignis* has done. It is a far more destructive species here than *O. insignis* so far as I have observed it.

ORTHEZIOLA.

(115) *Ortheziola fodiens.* Giard. in Guadeloupe.

A. Giard, *Compt. Rend. Soc. Biol.* Paris, Vol. iv., No. 22. pp. 583, 585, (1894.)

MARGARODES.

71. (116) *Margarodes formicarium.* Guild.

Rev. L. Guilding, *Transactions Linnean Society*, 1833, Pt I, p. 115.

Described from Union Island, Grenadines: it has also been found in Antigua, Bahama Isles (Guild.), Montserrat and St. Kitt's (Watts), and Barbados (Riley and Hubbard): it now occurs in Grenada and Barbados, in the former on Indian corn roots, and in the latter on sugar-cane roots.

(117) var. *Rileyi.* Giard.

A. Giard, *Compt. Rend. Soc. Biol.* Paris, Vol. iv., November 1894.

from Jamaica (Ckll.) and Florida (Riley and Howard).

ICERYA.

72. (118) *Icerya montserratensis.* Riley and Howard.

C. V. Riley and L. O. Howard, *Insect Life*, Vol. iii, p. 99.

Described from Montserrat on an undetermined plant. It has been found in Porto Rico on orange (Busck), in Trinidad by Mr. J. H. Hart on rose, *Clusia* and *Livistona*, in Grenada on a palm, and is also known from Colon and Columbia (Ckll.)

73. (119) *Icerya rosae.* Riley and Howard.

C V. Riley and L. O. Howard, *Insect Life*, iii, p. 99.

Described from Florida, since recorded from Jamaica and Trinidad (Ckll.). It is now found in Grenada on *Acacia sphaerocephala* in St. Lucia on *Croton discolor* and *Malpighia*, and in Antigua on *Saraca indica*.

It is a large insect, sparsely covered with wax, and when fully grown forms a conspicuous object on the bark of its food plant. Males also occur. In St. Lucia it was found both on the stem and roots of a *Malpighia* tree. It would appear likely to have originated in the West Indies.

RHIZOECUS.

74. (120) *Rhizoecus eloti.* Giard.

A. Giard, *Compt. Rend. Soc. Biol.* Paris, Vol. iv. No. 22., pp. 583, 585. (1894). Described from Guadeloupe.

This concludes the list of species and the first part of the paper. In the following number of the *West Indian Bulletin*, the distribution and habits of the above species will be dealt with, forming the conclusion of the paper.

VOLCANIC ERUPTIONS IN THE WEST INDIES.

The following account of the recent volcanic eruptions in the West Indies has been prepared by Dr. Longfield Smith, Ph.D., B.Sc, Lecturer in Agricultural Science, at Barbados, of the Imperial Department of Agriculture. It gives a connected narrative of recent events compiled from various published sources, in particular from the Preliminary Report of the Scientific Commissioners appointed by the Royal Society to investigate the phenomena. To this narrative is appended an account of the fall of volcanic dust at Barbados together with the results of chemical and mechanical analyses, which were in part performed by Dr. Longfield Smith:—

The recent terrible volcanic outbursts in the West Indies have attracted a great deal of interest to these islands, throughout the whole world, and have given them a rather unenviable notoriety. Sensational articles prophesying the complete annihilation of many, if not all, of the islands have been published in leading English and American newspapers and journals. These terrifying prophecies have no real foundation, and cannot be deduced from any analogy in nature. The writers of these articles contend that the enormous amount of matter ejected from the volcanoes must create a vacuum underneath, and that there will consequently be a sinking of the surrounding land. It must be remembered, however, that the activity of these volcanoes is probably the result of great internal pressure, and that the result of their activity will be to relieve this pressure rather than to create a vacuum.

LAND PROBABLY RISING.

Professor Milne, in an article contributed to *Nature*,* says: 'It would seem that instead of issuing an alarming prediction that the West Indies are to disappear from view, the recent eruptions suggest that they have risen to a greater height, whilst the water on their Caribbean side may have deepened. Two wrinkles on the face of the world have probably gained in height whilst the depth of the bounding furrows on their western flanks has probably been increased.'

TYPES OF VOLCANOES.

There are two well-marked types of volcanoes known to geologists—those which are in an almost constant state of eruption, and those which exhibit the phenomenon of paroxysmal eruptions followed by more or less prolonged periods of quiescence. To the former type belong Stromboli in the Mediterranean, Cotopaxi in Ecuador, the loftiest active volcano in the world; Izalco on the West coast of Central America, and many others.

Stromboli appears to have been in activity since the earliest recorded times, while Izalco first came into existence in 1770 and

* *Nature*, May 29, 1902.

has continued active ever since. It now forms a cone about 2,600 feet high, but in spite of the enormous amount of material ejected from this volcano there has been no great subsidence in its neighbourhood.

The volcanoes of the West Indies belong to the second or paroxysmal type. The last eruption of the Soufrière at St. Vincent was in 1812 when dust was blown to an enormous height and carried by upper air currents to Barbados 100 miles distant where it covered the whole island to the depth of about three-eighths of an inch. Mount Pelée at Martinique had been in eruption only fifty-one years before, but this eruption, though of a violent character, does not appear to have done very much damage.

THE OUTBURSTS OF 1902.

In the beginning of May 1902, these two volcanoes burst again into activity. Though sudden, the eruptions were not altogether unexpected. For over a year the inhabitants of Martinique and St. Vincent, living in the vicinity of the craters, had been startled by frequent and violent earthquakes, and at St. Vincent the Carib settlers to the windward of the Soufrière were considering the advisability of deserting the district.

Mount Pelée was the first to awaken from its repose. This mountain is the highest peak in Martinique, situated near the northern end of the island, and rising to a height of 4,450 feet. Early in April it began to emit smoke and continued to get more and more active until May 5, when a torrent of boiling mud swept down the mountain at a terrific speed, reaching the sea, five miles distant, in about three minutes. In its course it buried the Usine Guerin and caused considerable loss of life.

ERUPTION OF THE SOUFRIÈRE.

On the same day the Soufrière of St. Vincent, the highest peak in the island, (4,048 feet), and situated, like Mount Pelée, near the northern end of the island began to give signs of activity. At 3 p.m. on May 6, a dense cloud of steam burst from the mountain and on the same afternoon the cables between Martinique and St. Vincent were broken. The following account is taken from the preliminary report of Drs. Tempest Anderson, and J. S. Flett, the Commissioners appointed by the Royal Society to investigate the eruptions.*

'About mid-day on Tuesday, the first signs of the eruption were observed by those dwelling on the south-western side of the mountain. At 2.40 that afternoon there was a considerable explosion, and a large cloud of steam ascended into the air. By 5 o'clock a red glare was visible in the steam cloud on the summit Activity continued during the evening, and at mid-night there was a great outburst, and red flames were noticed on the lip of the crater. Next morning from Chateaubelair a splendid view could be obtained of gigantic mushroom-shaped

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* *Proceedings of the Royal Society*, Vol. 70, pp. 426 *et seq.*

clouds rising to a great height in the air—estimated at 30,000 feet—and drifting away before the north-east trade wind. As the day advanced the eruption increased in violence; by 10.30 a.m, enormous clouds of vapour were being emitted with loud noises, accompanied by much lightning. It is remarkable that at that time the inhabitants of the windward side were still in doubt about the reality of the eruption, since they mistook the dark cloud covering the mountain for a thunder cloud. The mountain was now in a state of continuous activity, and from Chateaubelair it could be seen that the materials were mostly discharged from the old or principal crater. Vast clouds of steam, showers of dark matter (probably mud), and of stones, could be seen projected from it, partly on the leeward but mostly on the windward side. At mid-day the slopes of the mountain were still green, and the rich mantle of tropical vegetation had not yet been destroyed. A thin layer of fine ash had fallen over the lower ground, only sufficient to give the leaves a greyish colour. The enormous columns of vapour continued to ascend from the crater, with frequent violent outbursts, projecting showers of stones and mud.

'About this time it was noticed that steam was rising from some of the valleys on the south side of the hill, and this increased till at 12.50 the whole mountain was suddenly enveloped in a dense cloud of vapour. Just before this the rivers Wallibou and Rabaca had been seen rushing down in raging floods of boiling water. It is most probable that these phenomena were due to the escape of the crater lake which was driven over the lower or south lip of the crater between 12 o'clock and 1 o'clock on the Wednesday afternoon, and poured down the valleys to the sea. So far as we know there were no mud lavas, in the ordinary sense, flowing down these valleys, but only a tremendous rush of boiling water, which left no traces which we could recognize when we visited the district.

'This rush of boiling water cut off the escape of the fugitives from the windward side of the island and caused the loss of about 2,000 lives.

'By one o'clock the roaring of the volcano was tremendous. Showers of stones were being projected to windward and to leeward. The enormous columns of steam continued to ascend from the crater. The lightnings were terrific, and after the large outbursts, which took place every few minutes, volumes of vapour might be seen covering the whole area. Hitherto the eruption had been of a type with which geologists are familiar, and the destruction done was confined to the higher parts of the mountain.

'But about 2 o'clock—to quote the words of an eye-witness (Mr. T. Macdonald, of Richmond Vale estate)—"there was a rumbling and a large black outburst with showers of stones all to windward, and enormously increased activity over the whole area. A terrific huge reddish and purplish curtain advanced to and over Richmond estate."

'This was the strange black cloud which, laden with hot dust, swept with terrific velocity down the mountain side, burying the country in hot sand, suffocating and burning all living creatures in its path, and devouring the rich vegetation of the hill with one burning blast.

'The cloud was seen to roll down upon the sea, and was described to us as flashing with lightning, especially when it touched the water. All state that it was intensely hot, smelt strongly of sulphur, and was suffocating. They felt as if something was compressing their throats, and as if there was no air to breathe. There was no fire in the ordinary sense of the word, only the air was itself intensely hot and was charged with hot dust. The suffocating cloud only lasted a few minutes. Those who survived this ordeal mostly escaped, though many died within a few hours from shock, or from the severity of their injuries. In some cases a few survived, entirely or almost entirely, uninjured, in a room in which many others died. Most of those who escaped had shut themselves up in the rum cellars or in substantially built houses, and had firmly closed all doors and windows. By the time the hot blast had reached the coast, the sand it contained was no longer incandescent, and though still at a very high temperature it did not set fire to wood or burn the clothes of those exposed to it. The burns on the survivors were chiefly on the outer aspect of the arms and legs, and on the faces, and confined to parts not protected by their clothes.

'Complete darkness now covered the whole north end of St. Vincent—a darkness more intense than any that the inhabitants had ever before experienced. The fugitives had to creep along the roads or feel their way along the roadsides. The roaring of the mountain was terrible—a long drawn-out continuous sound resembling the roar of a gigantic animal in great pain. Fine ash and sand rained down over the whole country with occasional showers of large stones. Some of these were so hot as to set fire to the "trash" roofs of huts in the south-end of Georgetown, at a distance of seven miles from the crater. In Kingstown, twelve miles from the Soufrière, the ash was at first moist but afterwards dry. It had a strong sulphurous smell, and pattered on the roofs like a heavy shower of tropical rain. Around the volcano the earth shook and trembled continuously, and the motion was described to us as undulating rather than resembling the sharp shock of an earthquake.

'Only in one or two cases were the walls of houses injured. What was taking place on the summit of the mountain no one can tell, but all who passed the night in the vicinity of the Soufrière agree that there was one black suffocating cloud and only one. In all probability the eruption had reassumed the ordinary phase, and the showers of ash and stones were produced by violent upward explosions of steam. By half-past 5 o'clock the ash was falling in Barbados, 100 miles to the eastward, whither it had been carried by the upper currents of air in a direction opposite to that of the trade winds. In St. Vincent the darkness lessened slightly before nightfall, but

the rain of dust and the noises lasted till early in the ensuing morning.'

So tremendous were the successive explosions from the crater when the avalanche of incandescent sand was hurled on the doomed inhabitants that the sound was heard loudly at Barbados where it caused the windows of the houses to rattle, and it is recorded that dust produced by the explosions was met by vessels at sea over 900 miles from the crater.

There can be little doubt that it was the dust produced by these terrific explosions which commenced to fall at Barbados three hours later. The dust must therefore have travelled in the upper air currents at the high rate of thirty miles an hour. It is estimated that altogether nearly two million tons of dust were deposited on Barbados. The total loss of life caused by this eruption at St. Vincent is estimated at over 2,000, and the whole of the Wallibou and Richmond plantations on the leeward coast were completely destroyed. On the Windward coast seven plantations were totally destroyed and the whole of the Carib country was covered with ashes to a depth of two to four feet. At Georgetown and at Chateaubelair some stones fell as much as a foot in diameter, and even at Kingstown, twelve miles distant from the volcano, there were stones as large as a hen's egg. At Wallibou, four miles from the crater, stones three feet in diameter were picked up. These stones consist of weathered andesite and tuffs such as compose the walls of the crater.

ERUPTION OF MT. PELÉE OF MAY 8.

But it was on the morning of May 8 that the most appalling disaster was to befall, and this time it was the turn of Mont Pelée. Monsieur St. Mate in his account states that 'between half-past six and seven o'clock on the fatal morning columns of white smoke suddenly emerged as if from a new crater about 600 feet below the top of Mont Pelée creating panic among the inhabitants of St. Pierre. At a quarter to eight a formidable rumbling was heard emanating from the mountain, as if a colossal fissure had been made from peak to foot, and then was beheld, amid black smoke which the eye could not penetrate, a great uniform mass, which burst with dizzy rapidity on the valley.'*

To quote again from the report of Drs. Flett and Anderson:† 'An avalanche of incandescent sand was launched against the city. In the north end which was nearest the crater, the inhabitants were instantaneously killed, the walls of the houses levelled with the ground, and the town was ablaze in a moment. In the south end the ruin was less. Those walls of the houses which faced the crater were demolished; those which run north and south still stood, even when we were there, after the second eruption. In this quarter also all were killed, except a prisoner who was confined in an ill ventilated

* *Geographical Journal*, Vol xx, p. 54.
† *Proceedings of the Royal Society*, Vol. 70, p. 440.

cell in the prison, but we were told that for some minutes after the blast had passed people were seen rushing about in the streets, crying aloud with pain, and many threw themselves into the sea to escape the agony of their burns. It must be remembered that a terrible conflagration followed the eruption, and for 36 hours the city was a burning pile. Another eruption followed on the 18th, and cast down many of the buildings which were left. Hence it was difficult to be sure exactly, what were the effects of the volcanic blast, and what had to be ascribed to the conflagration. But we saw enough to satisfy us that the hot blast was no less violent here than at St. Vincent. An iron statue of the Virgin, standing on a stone pedestal on the wooded cliff overlooking the town, had been broken off and carried 40 feet away. It lay with the head pointing to the mountain, and the direction of the statue showed that the blast was travelling straight from the crater over the city. The cannon in the fort had been overthrown and had fallen away from the mountain, that is to say, in the same direction as the statue. The projecting ironwork of the verandahs of the houses was twisted and bent. The lighthouses were razed. The ships riding at anchor in the harbour were lying side on to the blast. Some were capsized, others had their rigging cut clean away; only the *Roddam* escaped, and she was near the south end of the town. It was said that one man was blown clean off the *Roraima*. The trees which were growing in the streets were uprooted and cast down. Many of them showed charring and sand-blast erosion on the side which faced the crater, while the lee side was still covered with the original bark.'

There is undoubtedly much that is new to science in these eruptions, and many are the theories which have been advanced to explain their effects. Professor Hovey suggests that the destruction of St. Pierre was due rather to the passage of a tornado or cyclonic system which had formed over the crater than to a violent explosion. Drs. Flett and Anderson were, however, fortunate enough to witness unharmed an eruption of the crater probably quite as violent as, and an exact counterpart of, that which destroyed St. Pierre. Their experience does not bear out this view. They were also unable to see any sheet of flame or explosions of gases, both of which theories have been advanced in explanation of the terrible effects of the eruption. The account given by Drs. Flett and Anderson of their experience of the eruption of Mont Pelée on the night of July 9, is intensely interesting and is here reproduced in full.

ERUPTION OF MT. PELÉE OF July 9.

'On July 9 we were in a small sloop of ten tons, the *Minerva* of Grenada, which we had hired to act as a convenient base for our expeditions on the mountain. The morning was spent in St. Pierre city, and among the sugar-cane plantations on the lower slopes of the mountain on the banks of the Rivière des Pères. The volcano was beautifully clear. Every ravine and furrow, every ridge and crag, on its gaunt

naked surface stood out clearly in the sunlight. Thin clouds veiled the summit, but now and then the mist would lift sufficiently to show us the jagged, broken cliff which overlooks the cleft. From the triangular fissure which serves as the crater hardly a whiff of steam was seen to rise, and the great heap of hot boulders which lies on the north side of and above this fissure, could be perfectly made out. Small land-slides took place in it occasionally, and small jets of steam rose now and again from between the stones.

'A little after mid-day large steam clouds began to rise, one every ten or twenty minutes, with a low rumble. As they rose they expanded, becoming club-shaped and consisting of many globular rolling masses, constantly increasing in number and in size as they ascended in the air. They might be compared to a bunch of grapes, large and small, or to a gigantic cauliflower. When their upward velocity diminished they floated away to leeward, and fine ash rained down in a dense mist as they drifted over the western side of the mountain. They occasioned no anxiety in our minds, as we had found that the mountain was never long without exhibiting these discharges, and they were due merely to an escape of steam carrying with it fine dust. They rose, as a rule, to heights of 5,000 or 6,000 feet above the sea.

'That afternoon as the sun was getting lower in the heavens and the details of ravine and spur showed a contrast of light and shadow which was absent at mid-day, we sailed from St. Pierre to Prêcheur, intent on obtaining a series of general photographs of the hill. The steam puffs continued, and, about 6 o'clock, as we were standing back across the bay of St. Pierre, they became more numerous, though not much larger in size. We ran down to Carbet, a village one and a half miles south of St. Pierre, where there is a supply of excellent water and good anchorage. About half-past six it was obvious that the activity of the mountain was increasing. The cauliflower clouds were no longer distinct and separate, each following the other after an interval, but arose in such rapid succession that they were blended in a continuous emission. A third cloud of steam streamed away before the wind so laden with dust that all the leeward side of the hill, and the sea for six miles from the shore, was covered with a dense pall of fine falling ash. The sun setting behind this cloud lost all its brightness, and became a pale yellowish-green disc easily observable with the naked eye. Darkness followed the short twilight of the tropics, but a four-days'-old moon shed sufficient light to enable us to see what was happening on the hill-side.

'Just before darkness closed in, we noticed a cloud, which had in it something peculiar, hanging over the lip of the fissure. At first glance it resembled the globular cauliflower masses of steam. It was, however, darker in colour, and did not ascend in the air or float away, but retained its shape, and slowly got larger and larger. After observing it for a short time, we concluded that it was travelling straight down the hill towards us, expanding somewhat as it came, but not rising in the air, only rolling over the surface of the ground. It was so totally distinct in its behaviour from the ascending

steam clouds that our attention was riveted on it, and we were not without apprehension as to its character. It seemed to take some time to reach the sea (several minutes at least), and as it rolled over the bay we could see that through it there played innumerable lightnings. We weighed anchor and hoisted the sails, and in a few minutes we were slipping southward along the coast with a slight easterly wind and a favourable tide. We had, however, scarcely got under way when it became clear that an eruption was impending. As the darkness deepened, a dull red reflection was seen in the trade-wind cloud which covered the mountain summit. This became brighter and brighter, and soon we saw red-hot stones projected from the crater, bowling down the mountain slopes, and giving off glowing sparks. Suddenly the whole cloud was brightly illuminated, and the sailors cried, "The mountain bursts!" In an incredibly short space of time a red-hot avalanche swept down to the sea. We could not see the summit owing to an intervening veil of cloud, but the fissure and the lower parts of the mountain were clear, and the glowing cataract poured over them right down to the shores of the bay. It was dull red, with a billowy surface reminding one of a snow avalanche. In it there were larger stones which stood out as streaks of bright red, tumbling down and emitting showers of sparks. In a few minutes it was over. A loud angry growl had burst from the mountain when this avalanche was launched from the crater. It is difficult to say how long an interval elapsed between the time when the great glare shone on the summit and the incandescent avalanche reached the sea. Possibly it occupied a couple of minutes: it could not have been much more. Undoubtedly the velocity was terrific. Had any buildings stood in its path they would have been utterly wiped out and no living creature could have survived that blast.

'Hardly had its red light faded when a rounded black cloud began to shape itself against the star-lit sky, exactly where the avalanche had been. The pale moonlight shining on it showed us that it was globular, with a bulging surface, covered with rounded protuberant masses, which swelled and multiplied with a terrible energy. It rushed forward over the waters, directly towards us, boiling, and changing its form every instant. In its face there sparkled innumerable lightnings, short and many of them horizontal. Especially at its base there was a continuous scintillation. The cloud itself was black as night, dense and solid, and the flickering lightnings gave it an indescribably venomous appearance. It moved with great velocity, and as it approached it got larger and larger, but it retained its rounded form. It did not spread out laterally, neither did it rise in the air, but swept on over the sea in surging globular masses, coruscating with lightnings. When about a mile from us it was perceptibly slowing down. We then estimated that it was 2 miles broad, and about 1 mile high.

'It began to change its form; fresh protuberances ceased to shoot out or grew but slowly. They were less globular, and the face of the cloud more nearly resembled a black curtain draped in folds. At the same time it became paler and more grey in

colour, and for a time the surface shimmered in the moonlight like a piece of silk. The particles of ash were now settling down, and the white steam, freed from entangled dust, was beginning to rise in the air.

'The cloud still travelled forward, but now was mostly steam, and rose from the surface of the sea, passing over our heads in a great tongue-shaped mass, which in a few minutes was directly above us. Then stones, some as large as a chestnut, began to fall on the boat. They were followed by small pellets, which rattled on the deck like a shower of peas. In a minute or two fine grey ash, moist and clinging together in small globules, poured down upon us. After that for some time there was a rain of dry grey ashes. But the cloud had lost most of its solid matter, and as it shot forwards over our heads it left us in a stratum of clear pure air. When the fine ash began to fall there was a smell of sulphurous acid, but not very marked. There was no rain.

'The volume of steam discharged must have been enormous, for the tongue-shaped cloud, broadening as it passed southwards, covered the whole sky except a thin rim on the extreme horizon. Dust fell on Fort-de-France and the whole south end of Martinique. The display of lightning was magnificent. It threaded the cloud in every direction in irregular branching lines. At the same time there was a continuous low rumble overheard.

'What happened on Mont Pelée after this discharge cannot be definitely ascertained. For some hours afterwards there were brilliant lightnings and loud noises which we took for thunder. That night there was a heavy thunderstorm over the north end of Martinique, and much of the lightning was atmospheric, but probably the eruption had something to do with it, and the noises may have been in part of volcanic origin.

'There can be no doubt that the eruption we witnessed was a counterpart of that which destroyed St. Pierre. The mechanism of these discharges is obscure, and many interesting problems are involved. But we are convinced that the glowing avalanche consisted of hot sand and gases principally steam; and when we passed the hill in R. M. S. *Wear* a few days later, we had, by the kindness of the captain, an excellent opportunity of making a close examination of the shore from the bridge of the steamboat. The south-west side of the hill along the course of the Rivière Sèche was covered with a thin coating of freshly fallen fine grey ashes, which appeared to be thickest in the stream valleys. The water of the rivers flowing down this part of the hill was steaming hot. This was undoubtedly the material emitted from the crater on the night of the eruption. There was no lava. We saw no explosions of combustible gases, and nothing like a sheet of flame. We were agreed that the scintillations in the cloud were ordinary lightnings which shot from one part of its mass to another, and partly also struck the sea beneath.

NATURE OF THE DISCHARGE.

'The most peculiar feature of these eruptions is the avalanche of incandescent sand and the great black cloud which accompanies it. The preliminary stages of the eruption, which may occupy a few days or only a few hours, consist of outbursts of steam, fine dust, and stones, and the discharge of the crater lakes as torrents of water or of mud. In them there is nothing unusual, but as soon as the throat of the crater is thoroughly cleared, and the climax of the eruption is reached, a mass of incandescent lava rises and wells over the lip of the crater in the form of an avalanche of red-hot dust. It is a lava blown to pieces by the expansion of the gases it contains. It rushes down the slopes of the hill, carrying with it a terrific blast which mows down everything in its path. The mixture of dust and gas behaves in many ways like a fluid. The exact chemical composition of these gases remains unsettled. They apparently consist principally of steam and sulphurous acid. There are many reasons which make it unlikely that they contain much oxygen, and they do not support respiration.' *

After May 8, both volcanoes quieted down, though not for long, for on May 17 another violent eruption occurred at St. Vincent to be followed on the next day by a further eruption of Mont Pelée surpassing the first in violence. On July 9 both volcanoes burst forth again almost simultaneously, Mont Pelée with such violence that the noise of eruption was heard with great distinctness at Barbados and elsewhere in the West Indies. This was the eruption described by Drs. Flett and Anderson in the extract quoted above.

Very violent eruptions of both volcanoes took place again on the night of August 30. If one were to judge by the magnitude of the sound heard at Barbados this eruption of Mont Pelée was probably the most violent of all. The shock was so great as to shake the houses, sufficiently to cause, in some cases, the bells to ring, and to some it seemed as if we had received an earthquake shock. The sounds were like the reports of heavy distant cannon.

ABSENCE OF LAVA.

A very curious feature of all the eruptions both at St. Vincent and at Martinique is that no lavas have been produced. This is possibly due to the enormous amount of imprisoned gas and steam in the molten magma. This molten rock is forced to the top of the crater where it experiences a sudden release of pressure, the imprisoned gas expands suddenly with terrific explosive force bursting the molten magma into a fine incandescent powder which it hurls outwards and downwards with enormous force forming the terrible avalanche of hot sand described by all who have witnessed the explosions. This is borne out by the fact that the noise of the explosions appears to have been heard with little greater intensity in the vicinity of the crater than at Barbados, over

* *Proceedings of the Royal Society*, Vol. 70, pp. 441 *et seq.*

100 miles away. Captain McKay of the Quebec Steamship Company, who witnessed the eruption of August 30, says that the sounds of the explosions did not seem louder on the island of Martinique than those heard at Barbados on May 7. The explosions do not therefore, in all probability, take place until the molten magma reaches the top of the crater, and possibly the dense cloud of dust serves to some extent to deaden the sound of the explosion to those on the spot. The explosion is so sudden that it has no time to lift the air above it, and its force is therefore largely directed downwards as in the case of the explosion of a mass of dynamite.

It is quite probable we have not even yet heard the last of these eruptions, but we are so profoundly ignorant of their cause that nothing can be prophesied for the future.

NATURE OF WEST INDIAN ISLANDS.

With the exception of Barbados all the West Indian islands are of volcanic origin and all have their extinct or still slightly active volcanoes. There is, however. no need for any great anxiety in these other islands, for in all probability Mont Pelée and the Soufrière now form a sufficient vent for the internal volcanic forces.

It has been suggested, by some people in Barbados, that there may be some connexion between the landslide which occurred at Boscobel, Barbados, last year, and these volcanic outbursts. There is not the slightest reason, however, to suppose any connexion. The landslip at Boscobel was the natural result of a very heavy fall of rain percolating through porous rock and coming upon an impervious bed of blue clay along which it spread out in a sheet, running down the slope of the bed, and rendering the clay of the consistency of butter. The rock above being relieved of its support below, broke loose along certain cracks, and slid downwards over the slippery surface. Naturally, in breaking loose and cracking, there was a considerable local shaking of the ground, and a certain amount of noise produced. There is, however, not the slightest evidence of an earthquake having taken place. There are no volcanic rocks of any kind in the Scotland or any other district in Barbados.

THE FALLS OF VOLCANIC DUST.

The volcanic dust which fell at Barbados has been more thoroughly investigated than any which fell elsewhere, and it may be taken as representing fairly well the material ejected by the Soufrière. The dust was accompanied by a distinct smell of burning sulphur. It commenced to fall soon after 5 o'clock in the afternoon of May 7 and continued to fall in increasing amount until 8 p.m., when the fall was heaviest; the quantity which fell then gradually diminished and probably ceased altogether at about 7 a.m. of the next day, though the amount of dust blown about by the wind made it difficult to say definitely. So far as can be ascertained, the fall was uniform

over the whole island, and, as stated before, the total amount which fell was estimated at about two million tons.

The Harbour Master at Bridgetown, Barbados, has collected from captains of ships the following information relating to falls of volcanic dust encountered at sea between May 7 and 8.*

'May 7: Schooner *Viola*, from Demerara, met the dust at 8 p.m., 70 miles south of Barbados.

'May 7: Norwegian S.S. *Talisman*, from Demerara, met dust at 10 p.m., 150 miles S. S. E. of Barbados.

'May 8: Bktne. *Fanny*, from Pernambuco, met dust 250 miles east of Barbados.

'May 8: Barque *Jupiter*, from Cape Town, met dust at 2.30 a.m., 830 miles E. S. E. of Barbados.'

The fall of dust at Barbados both in 1812 and 1902 is interesting as establishing definitely the existence of prevailing air currents moving at a high rate of speed in the upper atmosphere in a contrary direction to the trade winds, which prevail at the earth's surface.

The dust is a grey-coloured fine powder strongly resembling cement in appearance, and emitting an earthy smell when moistened with water. When moistened it is almost black in colour.

The majority of the planters in the island expected to find the dust a fertilizer, for it was claimed that the dust of 1812 had produced an abnormally large crop in 1813. Chemical analysis has shown, however, that the dust can have no value as a manure, though Professor d'Albuquerque, Island Professor of Chemistry at Barbados, is of opinion that 'incorporated with the surface layers of our stiff clay soils it may to some extent improve their texture,' and the West India Committee have pointed out that the returns of the sugar crop for 1813 instead of being abnormally high were in reality abnormally low. Though not a fertilizer, the dust of 1902 contains nothing harmful to the land, and in the opinion of several people has done something to lessen the amount of blight due to scale insects.

CHEMICAL ANALYSIS OF THE DUST.

Chemical analyses of the dust by Dr. Pollard of the Geological Survey of Great Britain, and by Professor d'Albuquerque, are given on the following page. Both samples analysed were collected by Dr. Morris at Chelston from 4 p.m. on the 7th. till 5 a.m. on May 8.

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* *Agricultural News*, Vol. I, p. 60.

Dr. Pollard's analysis.

Silica	52·81
Titanium oxide	·95
Alumina	18·79
Ferric oxide...	3·28
Ferrous oxide	4·58
Manganese oxide	·28
Cobalt and Nickel oxides	·07
Calcium oxide	9·58
Magnesium oxide	5·19
Potassium oxide	·60
Sodium oxide	8·23
Phosphoric anhydride	·15
Sulphuric anhydride...	·33
Chlorine	·14
Water	·37
	100·35

Professor d'Albuquerque's Analysis.

	Total.	Soluble in Hydrochloric Acid.	Soluble in 1 per cent. Citric Acid.
Moisture	·190	...	...
Loss on ignition	·060	...	...
Alumina	21·648	12·460	...
Ferric oxide	6·372	2·890	..
Ferrous oxide		1·630	..
Calcium oxide	10·000	5·940	..
Magnesium oxide	4·716	·778	...
Potassium oxide	·675	·085	·016
Sodium oxide	3·551	1·155	...
Phosphoric anhydride	·141	·038	·022
Sulphuric anhydride	·124	·124	...
Sulphur as sulphides	trace	...	...
Titanium oxide	1·000	...	...
Silica (by difference)	51·523	·108	...
	100·000	..	...

MECHANICAL ANALYSIS OF THE DUST.

A mechanical analysis of the dust, conducted by Dr. Longfield Smith, at the Government Laboratory, Barbados, by means of sieves, gave the following results :—

Diameter of Particles.	Percentage.
·1 to ·5 millimeter	0·01
·5 to ·35 „	3·06
·35 to ·20 „	7·21
·20 to ·15 „	66·20
·15 to ·10 „	0·89
·10 and less „	22·63

Mineralogical examination of the dust has shown it to consist chiefly of mineral fragments, the minerals being lime-soda felspars, hypersthene, augite, and magnetite. There appear to be also a few fragments of sanidine and a very few fragments of quartz. The presence of these two minerals was detected in the residue left after digesting the dust particles of diameter ·2 to ·15 mm. with strong hydrochloric acid for one day. When this residue is stained with malachite green there are found two kinds of colourless crystals which have been almost unattacked by the strong acid. Of these two colourless minerals one shows low interference tints between crossed nicols, the colours ranging from white or yellow to grey. The other shows considerably higher tints, the colours being green and red. The latter particles are always quite free from stain and are probably quartz grains. They are present in only very small quantity, two or three grains only being found on a slide containing several hundred. The former particles are probably sanidine. They are also present only in small quantity though to a larger extent than the quartz. The grains exhibit well-marked zonal structure.

The particles of dust over ·3 mm. diameter are chiefly composed of volcanic glass which is crowded with gas bubbles. There are two distinct kinds of these glass particles. One kind is full of brown flakes probably of ferric oxide, while the other kind contains black flakes of magnetite. Both kinds of glass enclose small crystals and microliths of felspar. In some cases the glass particles are so full of gas bubbles as to be quite opaque.

Drs. Flett and Anderson, in their report to the Royal Society, state that the dust represents 'a fairly well crystallized hypersthene-andesite magma which has been blown to powder by the expansion of occluded steam.'

DUSTS OF 1812 AND 1902 COMPARED.

A comparison made of this volcanic dust, and of a sample obtained from the museum of the Government Laboratory, Barbados, of the dust of 1812, showed a considerable difference between the two. The dust which fell in 1812 is grey-brown in colour, and is composed of much finer particles. Under the microscope the larger particles are seen to consist

almost wholly of volcanic glass enclosing small crystals and microliths of felspar and crowded with brown grains probably of ferric oxide. The finer particles consist partly of glass and partly of mineral crystal fragments, the minerals being chiefly felspar with a small proportion of ferro-magnesian minerals and a very small proportion of magnetite.

The comparative coarseness of the dust particles of 1902 and the great predominance of heavy mineral particles point to the eruption of 1902 being of a more violent nature than that of 1812. It is rare to find so many mineral particles in volcanic dust scattered so far from the seat of eruption. These are generally sifted out by the wind from the lighter particles of glass. The fact that particles of magnetite, a mineral of specific gravity 5·5 to 6·5, of over one millimeter diameter should be found in the dust over 100 miles from the seat of eruption is significant of the prodigious height to which the particles must have been ejected.

It has been suggested that Barbados derives its soil entirely, or almost entirely, from periodic falls of volcanic dust blown over like that of 1812 and 1902 during periodic eruptions of the Soufrière, St. Vincent. There is however no evidence of this and no reason to suppose it. The limestone rock of which the island is chiefly composed contains a proportion of material insoluble in dilute acids, and it is this material which forms the soil of Barbados. It is true that a large amount of limestone must have been dissolved away by water containing carbonic acid in solution before a thick layer of soil could be formed, but the soil of Barbados is by no means deep.

Professor Harrison computes from an analysis of the coral rock that fifty to sixty cubic feet must have been required to produce one cubic foot of soil.

ERUPTION OF THE SOUFRIERE ON OCTOBER 15.

Whilst the preceding portion of this paper was passing through the press, a further eruption of the Soufrière at St. Vincent occurred.

According to the *Times* of St. Vincent, the eruption began about 7.45 p.m. on October 15 and continued until 9 p.m. when all seemed quiet again. 'The people on the Leeward and Windward coasts commenced at the first signs of the eruption to remove to safer localities, and this wise step has again been the cause of the saving of many lives, especially in the Carib country where the effects of the eruption have been, so far as we are able to ascertain to the present, most severe. There was a quiet interval of 3 hours. Then began a great electrical display at 11.45 which would have thrown the entire community in a panic, but for the excellent moonlight then prevailing, which greatly robbed it of its terrors. Sand, stones and ashes began to fall in the Carib country shortly after midnight and continued until 5 a.m., just before which time there was a short interval of dense darkness. At Chateaubelair

three very severe earth tremors were experienced between 3.25 and 4.20 this morning. In Kingstown they were only slightly felt. Sand fell in Georgetown it is said between 6 and 9 inches, and in the Mesopotamia valley, 12 inches, covering the vegetation of the valley. It is believed that the crops, especially the arrowroot, throughout the island will be greatly affected if not destroyed.'

In its issue of a week later the *Times* continues: 'The volcano continues active to a greater degree than it has at any time been since May 7. Columns of black smoke and flames are seen daily emitting from the crater. The burning sand which fell throughout the island to an inestimable amount, has destroyed the vegetation hitherto untouched in several parts of the Windward district, and the vegetable gardens which had recovered from the injury done to them by the previous eruptions are now completely destroyed. A heat wave pervades the devastated area, and in Georgetown the sand is so hot that the poor people cannot tread on it without their feet being scorched. Over six hundred people are compelled since the last eruption to sleep wherever they can get accommodation. Between 3 and 7 miles distance from Georgetown many of them have to be content with lodging on the roads.'

FURTHER FALL OF DUST AT BARBADOS.

As in the case of the eruption of the Soufriere on May 7 of this year, a fall of volcanic dust was experienced at Barbados. The Rev. N. B. Watson,[1] B.A., Vicar of St. Martin's, Barbados, made careful observations, at his residence situated on the windward side of the island, about 12 miles east of Bridgetown. His interesting notes give a clear and connected story of the progress of events and we reproduce them in full :

'*Tuesday, October 14, 1902.*

5 a.m.	Sky at east brilliant crimson. Dense cumulus clouds at N.E. & S.E. Atmosphere clear. Almost imperceptible breeze from S.E.
6 a.m.	Wind at W almost calm Sky almost cloudless.
10 a.m.	Bright sunshine, clear sky. Calm at west. Sun intensely hot.
11 a.m.	Intense heat, yet in shade only 83 F. Sky cloudless but hazy.
1 p.m.	Close, sultry, clear, but cool in shade. Intensely hot out of doors. Calm, any sound at a distance very perceptible. Temperature 83° F.
2 p.m.	Hazy, calm. Wind,[2] W.S.W. sultry, heat intense 84. Suggestive of earthquakes.
6 p.m.	Red sunset. Clear. Warm. 83½ F.
8 p.m	Clear. Damp. Dew. Wind,[3] S.W.

Wednesday, October 15, 1902.

5.15 a.m.	Eastern sky light red. Several bar clouds N. to S. about 25° from E.

5.50 a.m.	Sky less crimson, but beautiful tints of pink and brown still visible. Distant cirrus like blue bars traversing eastern sky at 40' from E.
6 a.m.	Sky dull and hazy, almost cloudless. A few cumulus clouds at N.W. and S. Their base about 25°. Light blue mist rising from fields. Temperature 80° F. Damp.
7 a.m.	Blue mist continues to rise but rapidly evaporating. Temperature 81° F.
10 a.m.	Sun hot, but less sultry than yesterday. Cirrus from N.N.W
11 a.m.	Calm. Sound perceptible. Sea very calm. Sultry. Horizon at W. blue-black cloud of small area, probably thunder cloud.
11.40 a.m.	Three loud rumbling noises heard at W., possibly thunder.
12 p.m.	Sultry and light breeze from S.S.E. Temperature 82°.
3 p.m.	Slight appearance of rain, small, soft-edged clouds passing over from S.S.E.
5 p.m.	Clear and light breeze S.E.
6.30 p.m.	Light shower of rain, ·08. Light breeze from E. Sea calm as a pond.

Thursday, October 16, 1902.

4.20 a.m.	* Several detonations heard, lasting from 4.20 to 4.45 a.m. About 9 sounds heard. Supposed at first to be distant thunder but found sky clear with the exception of a few cumulus clouds. Eastern sky hazy. Red glow at W. to S.W. caused by setting moon probably. From W. to N. dark.
	The detonations more resemble the rumbling of thunder than the boom of canon, but they are without doubt volcanic.
	Gentle breeze south of east, cool and damp. Temperature 79 F. Barograph slightly disturbed.
5.30 a.m.	Whole sky hazy, especially at E. and N. Dense blue-black horizon from W.S.W. to S. The upper edge of cloud well defined without irregularities and at a height of from 25° to 30°. Low stratus clouds at E., alto-cumulus at S.E. and from N.E. to W. Sky hazy from S.E. to W. by North. Temperature 79°. Cool damp breeze from S.E. Cirrus from W. to S.
6 a.m.	Dense cloud at W.S.S. spreading to S. Wind S.E. Temperature 80°. Sky tinged with greenish-pink: light lurid. 6.30 dust cloud evidently and spreading towards S.E. From W. to E. by North clear. Sky blue.
7 a.m.	Area of dust cloud increasing at S.W. Cloud intense blue-black and apparently moving S. of

* Several persons inform me that they heard loud detonations from 3 a.m. As I was not awake prior to 4.20 a.m. I am unable to verify it. (N.B.W.)

Barbados in a S.E. direction. Its northern edge is spreading, less dense, and is now at an angle of about 80° from S. Colour of upper edge copper-red. Large alto-cumulus clouds moving from S.E. to N.W. adds to wind appearance of dust cloud. Damp breeze from S.E. Decided smell of earth in atmosphere —resembling the smell of a damp dusty cellar.

8 a.m. Dust cloud increasing in density and size. Horizon obscured by its southern edge from W.S.W. to S. by W. From S. by W. to S.S.E. the lower edge is sharply defined and gradually raised to an angle of about 35°. Body of cloud passing S. of Barbados. Its northern edge spreading over island, has now attained to 95° from S. Sunlight partially obscured. Colour of sky overhead greenish-red. Growing dark. Temperature 81°. Gentle breeze from S.E.

9 a.m. The dense area of dust cloud extends now from W.S.W. to S.E. Its lower edge remains sharply defined from S. to S.E. and is gradually raised to about 40° S.E. A dense cirrus cloud, extending to about E.S.E. forms a back ground for the edge and brings out its density. Below this portion of the edge the sky is cloudless and greenish blue. Alto-cumulus cloud continues to cross dust cloud from S.E. Atmosphere sulphurous. Ground colour of sky is now dark grey. Upper edge of dust cloud spreading to N. and has attained to angle of about 120° from S. Getting dark. Sun obscured. Temperature 81½°. From N. to 60° comparatively clear.

9.40 a.m. Dust just commenced to fall here. It is very fine, light, grey, and moist enough for many particles to adhere together. It falls in little pellets which crumble on reaching the earth. Upper edge rapidly spreading towards north. Objects to S. obscured. Objects still visible from N.W. to E. Temperature 81½.° Intense calm.

10.30 a.m. Dust falling thicker. Objects from W. to E. by North almost obscured. Getting too dark to be able to write without aid of lamp.

11 a.m. Fall of dust from 9.40 a.m. to 11 a.m., 11·60 grms. per square foot. Dust falling faster, whole horizon obscured. Calm. Hills of St. John's to N.W., about 3½ miles off, entirely obscured. Dust particles finer than the dust of May 7. Up to the present hour no electrical display. Temperature 81½°.

12 p.m. Fall of dust per square foot from 11 a m. to 12 p.m. 27·53 grms. Sun totally obscured. Sky and surrounding country enveloped in a dense yellowish-green fog, not unlike the proverbial London fog. The cabbage palm walk at Kirton plantation, a distance of ¾ mile to N., is now invisible from here. Roofs of houses, fields and trees covered with dust.

The whole scene recalls that of a severe hoar-frost.

12 40 p m. Less dark than at 12 p.m., yet dust is falling thicker. Colour of atmosphere light brownish-red. Cumulus clouds passing give the sky a mottled appearance. The upper dust cloud is ferruginous. The lower clouds bluish-grey. Several black-birds perched on a tree limb from before 10 a.m. are still there.

1 p.m. Fall of dust per square foot from 12 p.m. to 1 p.m. 38·1 grms. Position of sun can be seen. Colour light reddish-green.

2 p.m. Fall of dust per square foot from 1 p.m. to 2 p.m, 13 52 grms. Fall of dust decreasing. Light enough to cast a feeble shadow just appeared. Outlines of St John's hills can now be discerned. Sun light again obscured (2.6 p.m.). Sky yellowish red. Temperature 82°, gentle breeze[2] from S.E.

3 p.m. Fall of dust per square foot 2 p.m. to 3 p m. 4·0 grms. Sun again obscured, but not so dark as from 10.30 a.m. to 1 p.m. Sky less yellow-red and more grey. Dust cloud does not appear to be of uniform density. Dust fall decreasing. Found several butterflies fluttering on the ground, probably stupefied by sulphurous fumes from dust. Temperature 81°. Gentle breeze from S.E.

4 p.m. Fall of dust from 3 p m. to 4 p m. per square foot 2 0 grms. Dust fall very slight now. Sky still overcast. Distant objects more visible. Found several large flies alive, but so prostrated could take them from the ground by their wings.

5 p.m. Fall of dust from 4 p.m. to 5 p m. 1·02 grms. per square foot. Sky less dense from W. to E. by North at an angle of 60° N., from 60° N to southern horizon denser, S. very dense. Temperature 80°. Barometer continues normal.

5.30 p.m. Dust fall very slight. Sky grey with reddish tint. Lurid red spot at 45° west, probably caused by rays of sun.

6 p.m. Fall of dust from 5 p.m. to 6 p.m. 0·42 grms. per square foot. Temperature 80°. Sky less dense, but still very hazy. Dust falling very slightly. Very light breeze from S.E. Light less lurid, but more light than at 11 a.m. Less hazy at south.

7 p.m. Fall of dust from 6 p.m. to 7 p.m. 1·12 grms. per square foot. Sky veiled in grey. Dust fall very slight. Shower of drizzle accompanied by light breeze lasting only a few seconds at 7.05 p.m.

8 p.m. Fall of dust from 7 p.m. to 8 p.m. 0·80 grms. per square foot. Sky much clearer. Some stars visible. Moon shining feebly. Cumulus clouds at north.

9 p m. Fall of dust from 8 p m. to 9 p.m. 0·22 grms. per square foot. Dust fall almost imperceptible now, Moon shining brighter. Sky clearing. Atmosphere clear of fog. Temperature 81° 9.30 p.m. Temperature 80½°. Dust still falling slightly, sky bright

Friday, October 17, 1902.

6 a.m. Fall of dust from 9 p.m. October 16 to 6 a.m. October 17, 1·22 grms. per square foot. Atmosphere clear. No fogs. Distant objects remarkably clear and visible. Sun rose low and bright. Eastern horizon bright blue. Cumulus at N. and S. Dust registered in rain gauge from 9.40 a.m. to 6 a.m. of 17th. 0·03. One of the curious features of this fall of dust, when the connexion of clouds and earth by dust particles is considered, is the total absence of any electrical phenomenon. Occasional tints of a reddish hue were observed, but these were lasting and did not exhibit the slightest degree of tremulousness. Neither detonations, rumblings, nor sounds of any unusual character observed here after 4.45 a.m. of the 16th. Unlike the dust fall of May 7, the upper current of air appears to be north of west and so the cloud instead of approaching the island at W., as it did on May 7, has passed S. of Barbados, moving in a S. E. direction. The S.E. edge of the cloud was well defined from the time when it was first observed until it was obscured by the falling dust, while the northern edge was soft and spread much as a nimbus would prior to emptying itself.'

The total weight of dust collected by the Rev. Watson from 9.40 a.m. on October 16 to 6 a.m. on October 17, on one square foot was 101·55 grammes, or at the rate of about 3·94 tons per acre.

Mr. R. Radclyffe Hall, Acting Island Professor of Chemistry at Barbados sends the following particulars with regard to the dust fall at Bridgetown and also at Hastings, some three miles south-east of Bridgetown.*

'Samples were collected at the Government Laboratory in Bridgetown from 9 a. m. to 11 a.m., from 11 a.m. to 1 p.m., and from 1 p.m. to 3 p.m.: the blowing about of the dust by the breeze in the earlier hours of the morning of the 17th. prevented the last sample, collected between 3 p.m. on the 16th. and 8 a.m., on the 17th, being of any statistical value: the rate of fall was as follows:—

October 16.

From 9 a.m. to 11 a.m. at the rate of ·48 tons per acre.

From 11 a.m. to 1 p.m. at the rate of 2·10 tons per acre.

From 1 to 3 p.m. at the rate of 1·34 tons per acre.

Total from 9 a.m. to 3 p.m. at the rate of 3·92 tons per acre.

'I also collected two samples at "Rosebank," Hastings, about two miles south-east of Bridgetown, where the fall was:—

'From 8.45 a.m. to 4 p.m. on 16th., at the rate of 4·59 tons per acre.

'From 4 p.m. on 16th. to 7 a.m. on 17th., at the rate of ·20

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* *Agricultural News*, Vol. I., p. 233.

tons per acre. Of this ·20 I estimate about ·13 tons per acre had fallen by 5·30 p.m. on the 16th.

'These figures suggest that the fall at Hastings was heavier than that in the neighbourhood of the Government Laboratory. I had previously formed the idea that the cloud was heavier towards its south-westerly side, and it seemed to me that it was darker at Hastings than further inland and towards the City, in fact we appear to have obtained in this case rather the "tail end" of the dust storm: the coarser particles may have travelled in a more southerly direction than the previous one of May 7 and then have fallen in the sea to the south-east of Barbados.

'If this were so, it would account for the fall beginning so long, nearly 6 hours, after the eruption, and we should also expect to find that the fall was heavier on the south-easterly side of the island.'

The dust has been submitted to a preliminary microscopic examination by Dr. Longfield Smith who reports:

'I have examined the volcanic dust which fell here on October 16, 1902, and find it to be of much finer texture than that which fell between May 7 and 8, all the grains being less than one millimeter diameter, while 77·37 per cent. of the dust from the former eruption of the Soufrière was coarser than one millimeter.

'I collected dust at "Nonpareil," Hastings, every hour from 9.15 till 2.15 and then from 2.15 till 3.45, and found very little difference in texture or composition between the successive samples.

'The particles consist chiefly of minute fragments of felspar with a little volcanic glass, some ferro-magnesian minerals and a very little magnetite.

'The dust differs therefore considerably in composition from that which fell on May 7 and 8, which consisted largely of ferro-magnesian minerals and contained a considerable amount of magnetite.

'On this account the dust is likely to prove of greater fertilizing value than that of May 7 and 8.'

EFFECT OF VOLCANIC DUST ON INSECTS.

The following notes by Mr. H. Maxwell-Lefroy, Entomologist of the Department are added in completion of this account:—

The fall of volcanic ash on October 16 afforded a good opportunity of determining the exact effect on the insect fauna of this thorough application of fine dust, a far more thorough treatment than any that could have been artificially produced. Dust has been an ingredient of many insecticides in former times, either as a dilutent of strong arsenical poisons or because a powdered insecticide was thought to have special effect by acting on the respiratory system of insects. In this case, there was no question of stomach or contact poison: the

dust was likely to affect the insect life solely because it might act mechanically in closing the *stigmata* or openings of the respiratory system. Doubtless the fine dust might also affect the insects living in or on the ground, but as these are few and no accurate observations were possible, this factor is here neglected

The dust ceased to fall in Bridgetown about 3 p.m. on October 16, and very careful observations were made, chiefly on the next day when the dry dust was blowing about and the general conditions were much as when the dust fell. The work was done on three estates near Bridgetown, chiefly on one which has been very thoroughly collected over during the six weeks immediately preceding the fall of dust. So thoroughly had this collecting been done that it was possible to estimate very closely the insects that would be found in any part of the estate, and thus this locality afforded a very good opportunity of comparing the condition and quantity of the insects found before and after the fall of dust.

Generally speaking the dust had little apparent effect on the insects. The conclusions arrived at were briefly that, though all insects hid themselves during the actual fall of dust (and many till the next day), all groups were as abundant and active on the following day with the exception of the *Diptera*, *Hymenoptera*, and *Odonata*.

Of the *Orthoptera*, none appeared to be affected in any degree. The common earwig (*Anisolabis* sp.) was to be found as usual, as was the field cockroach. *Acridiidae* and *Locustidae*, (short horned and long horned grasshoppers) were moving freely in the clouds of dust among the grass and seemed in no way affected. There was no opportunity of finding any specimens of the Stick insect (*Bostra* sp.) or of the common mantid (*Musonia surinama*), but the latter has proved to be as abundant as usual since that time. Of the *Neuroptera*, the common *Chrysopa* was plentiful in the corn and cane fields, and neither the adult nor the larva suffered in any degree. *Psocidæ* on the plants were unharmed, but there appeared to be a notable absence of *Odonata* (dragon-flies). This however, is not in accordance with the observations of Dr. R. Hamlyn-Harris, who noticed dragon-flies hawking as usual. Other groups of *Neuroptera* are practically unrepresented in this island.

Hymenoptera would seem to have suffered, especially those not nesting in houses or other shelter to which the dust never reached. The common *Ophеon* was not to be found, nor was the *Chalcid* usually abundant in this locality. *Apidae* disappeared for some days from their usual haunts, but the hive bees were not affected to any extent in their hives.

Polistes, *Sceliphron* and *Dielis* disappeared almost completely from their usual haunts, and the only live *Polistes* to be found were those resting in buildings. Whether the dust killed many *Hymenoptera* is not certain, but it certainly put a stop to their visiting their usual haunts in the field, and this was noticeable for quite ten days after the fall of dust.

Formicidae sheltered in their nests, but those which were

fully exposed to the dust died in many cases. Since then many colonies of ants have shifted their nests to higher localities as if to get above the dust. *Coleoptera* appeared to be totally unaffected, though it was difficult to make any observations on this group. The common Scarabeid, *Ligyrus tumulous*, was certainly unaffected as was the weevil *Sphenophorus sericeus* and the *Coccinellidae* generally.

Chysomelidae and *Cerambycidae* equally were unaffected and could be caught as usual.

Lepidoptera were distinctly unhurt by the dust Butterflies appeared soon after the dust ceased to fall, and the moths equally were just as numerous and as active. It is unnecessary to specify the names, but the writer was fully satisfied that any species common in the usual localities was equally so on the day after the fall of dust. This applies also to the caterpillars.

Diptera were most markedly absent and were found in a dead or dizzy condition. This group forms a very large part of the fauna of a cane or a corn field, and was practically completely absent for days after the dust fell. A few found on the first day were dead, others were stupid and unable to fly, and there has since been a great absence of *Diptera* in the field.

Hemiptera were, so far as could be seen, unaffected.

Pentatomidae were distinctly unharmed, as were the aquatic species and pond skaters. *Tingitidae*, *Fulgoridae*, *Cercopidae* and *Jassidae* were obviously unharmed, and these make up the chief part of the local *Hemiptera*. *Coccidae* and *Aphidae* were equally unaffected.

Summing up, it appears to be fairly certain that the fall of this large amount of dust has had a very small immediate effect on the insect fauna. The only groups which can be said to have been affected were *Odonata*, *Hymenoptera* and *Diptera*, and there is some doubt as to the truth of this in the first of these groups. Otherwise no effect has been discernible. Beyond the insects it would seem that no part of the fauna was really affected otherwise than by the discomfort and uneasiness consequent to the phenomenon and the unusual darkness of the day.

THE SOURCE OF BARBADOS ALOES.

In the preceding number of this volume, page 179, it was said 'that the identity of the species [of aloe] cultivated in Barbados does not appear to have ever been determined with certainty. It was at one time definitely stated to be *Aloe vera* Linn., of which *Aloe barbadensis* and *Aloe vulgaris* are synonyms. The identification by Mr. J. G. Baker, F.R.S., of Kew, of the Curaçao aloe as *Aloe chinensis*, Baker, and its great similarity in appearance and character of its product to the Barbados aloe made it not improbable that the Barbados plant was also *Aloe*

chinensis. Complete specimens have recently been sent to Kew, and the result of their examination will be communicated later.'

The statement as to the great similarity of the plants was made as a result of a comparison of specimens of the aloes actually cultivated on College estate, Barbados, and plants cultivated at the Botanic Station, Dodds, obtained originally from Curaçao. The Barbados plant was later compared carefully with the description of *Aloe chinensis*, given in Mr. Baker's 'Synopsis of Aloineae and Yuccoideae' (*Journal of the Linnean Society,* Vol. xviii, pp. 148-241). It was then found that it did not agree in several characters with *Aloe chinensis* but appeared to approach much more closely to *Aloe vera.*

The result of the examination of dried and spirit-preserved specimens, and photographs, at the Royal Gardens, Kew, has been the determination of the plant forwarded from the patch at College estate as *Aloe vera*, Linn. (A. barbadensis, *Mill.*) The table given on page 179 of the sources of the commercial varieties of aloes may now be completed as follows:—

Kind of Aloe	*Yielded by*
Curaçao aloes (usually called 'Barbados aloes' in the market) ...	...*Aloe chinensis.*
Barbados aloes	...*A. vera.*
Socotrine aloes	...*A. Perryi.*
Cape aloes	...*A. ferox* and other species.
Natal aloes	" " " "

Further information is needed, as to whether more than one species of aloe is cultivated in Curaçao and the neighbouring islands, and used for the preparation of Curaçao aloes.

Aloe vera is usually regarded as a native of the Mediterranean region of Europe, and this view is accepted by Mr. Baker, who adds that it is now distributed throughout the warm regions of both hemispheres.

Of the antiquity of its cultivation in Barbados, Ligon's account, quoted above (p. 178) bears witness, his visit to Barbados having been paid in 1647. Moreover, Mr. Baker states that *Aloe vera* was introduced from Barbados into English gardens in the year 1596, whence it was called *Aloe barbadensis* by Miller. Possibly for 1596, we should read 1696 as Barbados was not colonized until 1604. Of the original introduction of the aloes into Barbados little seems to be known with certainty.

SCALE INSECTS OF THE WEST INDIES.*

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The following pages contain a continuation of the paper published earlier in this volume of the *West Indian Bulletin*, pages 240 to 270. With the exception of the section on 'Native and Introduced Species,' the observations below refer solely to the seventy-four species found in the Lesser Antilles. No reference is made to the habits, etc., of the scale insects found in Trinidad, Jamaica, or elsewhere, outside the Lesser Antilles, as defined on page 241.

The following subjects are here dealt with :–

- Native and Introduced Species.
- Species likely to be introduced to Foreign Countries from the West Indies.
- Wild and Cultivated Species.
- Coccids and Ants.
- Habits.
- Foodplants.
- Males.
- Enemies (Predators).
- Parasites.
- Diseases.
- The place of *Coccidae* among Economic Insects.
- Plant Species.
- Control.

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* Concluded from page 270.

NATIVE AND INTRODUCED SPECIES.

In distinguishing the species native to the West Indies from those which have been introduced, I have made use of evidence coming under the following heads:—

Recorded Geographical Distribution. This has been studied as completely as the literature at my command will allow and, evidently, it is valuable evidence.

Foodplants. This evidence is also of value. In the West Indies, we find the plants may be classified as native plants, wild and cultivated; and exotic plants, wild and cultivated. When a scale insect attacks a large number of wild native plants, it would appear to be a native species: so also if it is confined to exotic plants cultivated in gardens or estates, it appears to be an introduced species.

Habitat. Some scale insects are markedly confined to cultivated land and have not spread further: these are likely to be introduced species. Others are found far from cultivation and spread in from there: these are likely to be native species.

Statements of Writers on Coccidae. There are occasional statements on this point in the literature, based on different evidence: these have been largely taken into account. It is much to be hoped that more attention will be paid to this. For instance, Mr. Cockerell's Check List in many cases places the origin of each species in some Zoological region. I have no knowledge of the data on which he proceeded, but I have every belief that, with his wide knowledge and large amount of information, he is eminently qualified to express an opinion.

Doubtless many students of *Coccidae* will differ from my conclusions. I trust that my attempt will at least lead to an increased interest in this question and that the original homes of our recorded species may be settled before the facts are irrevocably obscured by the spread of these insects to further localities.

NATIVE SPECIES.

Native species found in the Lesser Antilles, not found in the larger islands:—

Chionaspis major. Antigua only.

This differs little from *Chionaspis minor* and may be a local species arisen from the latter.

Pulvinaria ficus. This occurs also in Brazil.
Pulvinaria Broadwayi. Grenada only.
Ceroplastes cirripediformis, var. *plumbaginis.* In Antigua, probably a local variety of the neotropical species.
Ceroplastes Dugesii. Neotropical.
Ceroplastes denudatus. Also in Demerara.
Lecanium punctatum. Grenada only.
Lecanium assimile, var. *amaryllidis.* Antigua only.
Lecanium batatae. Antigua only.
Lecanium begoniae. Antigua and Demerara.

Asterolecanium bambusae, var. *bambusulae*. Grenada, local variety.

This is a total of only eleven species: there is among them nothing striking or distinctive. We may add the two species found in Guadeloupe, *Rhizoccus cloti* and *Ortheziola fodiens*. There are also some species which I have in my collection, unnamed and apparently new, of which further material must be obtained.

Native species found in Trinidad, not found in the other islands:—

Aspidiotus Hartii, var. *Luntii*. Peculiar.
Chionaspis aspidistrae. Also in Brazil.
Pinnaspis buxi, var. *alba*. Peculiar.
Pulvinaria brassiae. Peculiar.
Inglisia vitrea. Peculiar.
Lecanium nanum. Peculiar.
Ripersia serrata. Peculiar.
Asterolecanium aureum. Peculiar.
Dactylopius virgatus var. *farinosus*. Peculiar.

This is a total of nine species including two genera, *Inglisia* and *Ripersia*, not found elsewhere in the West Indies.

Native Species in Trinidad and the smaller islands, not found in Jamaica:—

Pulvinaria simulans. Barbados and Trinidad.
Pulvinaria urbicola. Barbados and Trinidad.
Lecanium Urichi. Grenada, Trinidad and Brazil.
Dactylopius sacchari. Barbados and Trinidad.
Asterolecanium Urichi. Grenada and Trinidad.
Ceroputo Barberi. Antigua, St. Kitt's and Trinidad.

This amounts to six species with one distinctive genus, *Ceroputo*.

Native species in Trinidad and Jamaica, not found native in the small islands:—

Aspidiotus biformis. Also in Central America.
Aspidiotus palmae.
Conchaspis angraeci.
Asterolecanium miliaris.
Asterolecanium epidendri.

A total of five species, small as would be expected.

Native species in Jamaica, not found in Trinidad or the Lesser Antilles:—

Aspidiotus biformis, var. *cattleyæ*.
Aspidiotus biformis, var. *odontoglossi*.
Aspidiotus Bowreyi.
Aspidiotus dictyospermi, var. *jamaicensis*.
Aspidiotus lateralis.
Aspidiotus mangiferae.
Pseudoparlatoria ostreata.
Ceroplastes confluens
Ceroplastes depressus.
Ceroplastes euphorbiae.
Ceroplastes jamaicensis.
Ceroplastes utilis.
Lecanium hemisphaericum, var. *hibernaculorum*.
Lecanium rubellum.
Lecanium terminaliae.
Lecanium tesselatum, var. *swainsonae*.

Diaspis calyptroides, var. *opuntiae*.
Mytilaspis crotonis.
Mytilaspis albus.
Pinnaspis bambusae.
Pulvinaria cupaniae.
Pulvinaria dendrophthorae.
Ceroplastes albolineatus.
Dactylopius filamentosus.
Dactylopius segregatus.
Dactylopius simplex.
Tachardia gemmifera.
Asterolecanium palmae.
Margarodes formicarium, var. *Rileyi*.

A total of twenty-eight species including two genera, *Tachardia* and *Pseudoparlatoria*, not found elsewhere in the West Indies.

Phenacoccus helianthi, var. *gossypii*, Porto Rico.

Native species found in the small islands and Jamaica :—

Aspidiotus punicae. Dominica and Jamaica.
Dactylopius brevipes. Antigua, Dominica and Jamaica.
Pseudococcus tomentosus Newsteadi. Jamaica and Antigua.

Native species common to the whole group of islands :—

Aspidiotus articulatus. Neotropical and general.
Aspidiotus Hartii. Peculiar.
Aspidiotus sacchari. Also in Java.
Aulacaspis pentagona. General.
Protopulvinaria pyriformis. Peculiar.
Ceroplastes cirripediformis. Neotropical.
Ceroplastes floridensis. Neotropical and Ceylon.
Dactylopius virgatus. Also in India.
Asterolecanium pustulans. Neotropical, etc.
Orthezia insignis. General.
Orthezia praelonga. Also in Demerara.
Margarodes formicarium. Neotropical.
Icerya montserratensis. Neotropical.
Icerya rosae. Neotropical.

This is a total of only fourteen species.

Tabulating these figures we get :—

Trinidad	... 9
Trinidad and small islands ...	... 6
Trinidad and Jamaica ...	... 5
Small islands	... 13
Small islands and Jamaica ..	... 3
Jamaica	... 29
West Indian	... 14

The most striking facts here seem to be that, whereas Jamaica has twenty-nine peculiar species, Trinidad has but nine ('peculiar,' here refers only to West Indies) : and that whilst we have six common to Trinidad and the small islands, and also fourteen common to all, we have but three common to Jamaica and the small islands. It must be remembered that we are dealing with supposed native species, most of them uncommon, and that the presence of Mr. Cockerell and Mr. Townsend in Jamaica would tend to the recording of the rarer species that might have escaped notice elsewhere. The figures, whatever

they may be worth, fail to give any facts of interest: there is no evidence for instance of Trinidad having many forms common also to the mainland of South America which have not reached Jamaica.

INTRODUCED SPECIES.

In dealing with these it is unnecessary to separate those which have been introduced to the different islands. Introduction is probably a matter of chance, depending largely on the number of plants imported to each island, the places they come from and the measures taken to keep the scale insects from becoming established when introduced. Until steps are taken to deal with this question, new species may be entering at any time from Europe, United States, Central or South America.

We may however divide such species as are apparently not West Indian, but yet neotropical, from such as have probably originated outside the neotropical region.

Neotropical species:—

Aspidiotus personatus.
Aspidiotus dictyospermi.
Aspidiotus ficus.
Diaspis calyptroides.
Chionaspis citri.
Dactylopius nipae.
Dactylopius dubia.

Species from more distant regions:—

Aspidiotus destructor.
Aspidiotus hederae.
Aspidiotus aurantii.
Aspidiotus tesseratus.
Aspidiotus camelliae.
Aspidiotus uvae.
Fiorinia Fioriniae.
Parlatoria proteus, var. *crotonis.*
Parlatoria Pergandei.
Diaspis Boisduvalii, var. *maculata.*
Aulacaspis rosae.
Chionaspis biclavis.
Mytilaspis citricola.
Mytilaspis Gloveri.
Pinnaspis buxi.
Ischnaspis filiformis.
Vinsonia stellifera.
Lecanium depressum.
Lecanium hemisphaericum.
Lecanium hesperidum.
Lecanium mangiferae.
Lecanium nigrum.
Lecanium oleae.
Lecanium tesselatum.
Dactylopius adonidum.
Dactylopius citri.
Asterolecanium bambusae.

These are introduced but possibly from the neotropical region.

Species doubtful in origin:—

Aspidiotus cydoniae.
Chionaspis minor.
Lecanium longulum.
Dactylopius calceolariae.

This totals 36 introduced species.
4 doubtful species.
80 native species.

In considering closely the distribution of *Coccidae*, one meets with curious cases. Such is the *Dactylopius calceolariae*, found by Mr. Maskell in New Zealand, subsequently in Fiji. The Jamaica sugar-cane insect is regarded by Mr. Cockerell as the

same, and is also found in Barbados. How comes this curious fact? Is the West Indian species actually the New Zealand or Fiji insect, and if so, how did it come here; or are the two descended from dissimilar ancestors but now anatomically indistinguishable, having been produced under possibly similar conditions in widely separate localities? Or is our specific distinction at fault? Or was *D. calceolariae* once a worldwide species and now exists only in these localities, having died out in the intermediate places? These are questions to which there seems no answer. Could we find an answer much light might be thrown on the geographical spread of Coccids, as also of other insects.

SPECIES LIKELY TO BE INTRODUCED TO FOREIGN COUNTRIES FROM THE WEST INDIES.

In studying the scale insects of the smaller islands, two facts are prominently noticeable: (1) the abundance of a definite number of species of these insects and the great variety of plants they attack, (2) the fact that most of these are introduced species. In a recent paper (*West Indian Bulletin*, Vol. III, pp. 140-51) I pointed out that, of our most destructive species, the majority were introduced and that native species were usually far less abundant and destructive. On further studying the geographical distribution of these introduced species, their wide range becomes noticeable, and it is evident that, where scale insects are so abundant and live on a large variety of cultivated plants, there is a great probability of many of our native and introduced species being spread from these islands either to other tropical or sub-tropical places or to greenhouses in temperate climates.

In a recent paper* Mr. King and Dr. Reh enumerate seven species of *Lecanium* found on introduced plants in Germany; these include *Lecanium hemisphaericum* on plants from South America and Trinidad, *Lecanium hesperidum*, *Lecanium longulum*, and *Lecanium oleae* from various places. These four are common West Indian species, easily introduced on plants from these islands.

In another paper, abstracted in *Bulletin 22, N. S. United States Department of Agriculture, Division of Entomology*, page 791, Dr. Reh deals with certain *Aspidioti* imported to Germany on American fruit.

The case of the Lantana Bug in Ceylon, described by Mr. Green in *Circular 10, Royal Botanic Gardens, Ceylon*, is a conspicuous case, where a probable West Indian species, *Orthezia insignis*, was introduced and caused a considerable amount of destruction: a similar case is the White Peach scale, *Aulacaspis pentagona.*

The literature abounds in such instances familiar to all who study *Coccidae*, and I wish here to draw attention to the species common in these islands, which are likely to be imported on plants, and against which horticulturists will need to guard.

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* *Jahrbuch der Hamburgischen Wissenschaftlichen Anstalten* xviii, 1900.

The following list includes the most abundant and destructive at present in the islands. They have a large range of foodplants in every case, mostly cultivated fruit trees or ornamental plants. I am not competent to speak of Jamaica or Trinidad; but in the smaller islands, I know from constant personal observation, as well as from the information given by the Curators of the Botanic Stations and other persons, the most likely species to be spread from the West Indies:—

Aspidiotus articulatus.	*Lecanium hemisphaericum.*
Aspidiotus destructor.	*Lecanium hesperidum.*
Aspidiotus personatus.	*Lecanium mangiferae.*
Aulacaspis pentagona.	*Lecanium nigrum.*
Chionaspis minor.	*Lecanium oleae.*
Pinnaspis buxi.	*Dactylopius adonidum.*
Ischnaspis filiformis.	*Dactylopius citri.*
Protopulvinaria pyriformis.	*Asterolecanium pustulans.*
Vinsonia stellifera.	*Orthezia insignis.*
Ceroplastes floridensis.	*Orthezia praelonga.*

In addition there are the Coccids that attack only a few plants, such as the citrus *Coccidae*:—

(Aspidiotus articulatus.)	*Chionaspis citri.*
Aspidiotus aurantii.	*Mytilaspis citricola.*
Aspidiotus ficus.	

and the orchid *Coccidae*:—

Conchaspis angraeci (rare.)	*Vinsonia stellifera.*
Aspidiotus biformis.	

There are also *Coccidae* on palms, bamboos, crotons and other plants. These are the most likely, but, of course, any Coccid on cultivated plants is capable of being distributed from here, and we may also remember that the abundant species change slowly from year to year.

Many of these *Coccidae* are already found in hothouses and greenhouses in various parts of the world. Mr. King's paper on greenhouse *Coccidae** enumerates fifty-six species, of which thirty live at the present time in the open air in the West Indies. In another paper† on the *Coccidae* of the Harvard Botanic Gardens, Mr. King mentions nineteen species, of which eleven are found in the West Indies. Mr. Green and Mr. Newstead studied the *Coccidae* of the Royal Botanic Gardens, Kew, and found twenty-two species, of which nineteen occur in the West Indies. Mr. E. P. Felt characterizes twenty-two out of seventy-eight species of *Coccidae* in New York State as 'greenhouse species' and eighteen of these are among the West Indian fauna. These figures show plainly that tropical and greenhouse scale insects are closely similar, and it would be interesting to know whether more of our West Indian species have come from greenhouses in temperate latitudes than *vice versa*.

These facts throw light on the distribution of scale insects from one place to another, and I question whether a Wardian

* *Entomological News*, Dec. 1901, and May 1902.
† *Psyche*, January 1901, p. 152.

case of plants from any of these islands would not be found to contain more than one species of scale insect. This danger is very obvious to any one in these islands, where under the continual steady high temperature, *Coccidae* multiply and spread to an astounding extent; but it is by no means easy to bring this fact before the notice of horticulturists and others in colder climates where the winter checks the spread of outdoor species, and where it is also comparatively easy to rid an enclosed greenhouse of its blight. Wherever a large variety of plants are brought together and cultivated, either in the tropics or in the favouring circumstances of a greenhouse or hothouse, there the best conditions are established for a number of *Coccidae* to live and spread. This danger is naturally much magnified wherever plants are brought together from all parts of the world, and probably also by the fact that where large numbers of plants are grown together, some must be living under unfavourable conditions and cannot therefore be in the full vigour they would be in their natural habitat, being then more suitable hosts for scale insects. The latter fact is probably one of great importance, applying both to Botanic Gardens in tropical or sub-tropical localities, and to greenhouses and hothouses in temperate climates.

The part played by Botanic Gardens and nurseries in spreading scale insects, collected with the plants from all parts of the world, is little realized, and the most stringent steps should be taken to guard against this. The destruction of scale insects in nurseries and greenhouses is perfectly feasible. It is recognized that great care is needed to prevent the West Indian Botanic Stations becoming centres of pest distribution, and very careful steps are taken to prevent seedling plants being sent out with any scale on them; and the same should be done in every nursery or garden whence plants are distributed.

This is fully recognized as a necessity in some countries, notably in America; but it does not yet appear to be adequately realized in England. Not only is the importation of plants from the West Indies likely to lead to fresh 'greenhouse' species in England, but the plants sent to the West Indies are likely to bring scale insects which will thrive in the open air. There can be little doubt that our thirty-six introduced species, which include the majority of the very destructive ones, have been brought to the West Indies on plants. This fact has been recognized and is being dealt with in the West Indies, but it deserves attention also from importers of West Indian plants.

It is interesting to note that some eight species, regarded as West Indian originally, are already known outside the neotropical region. These are:—

Aspidiotus articulatus.	*Ceroplastes floridensis.*
Aspidiotus sacchari.	*Dactylopius virgatus.*
Aulacaspis pentagona.	*Asterolecanium pustulans.*
Ceroplastes denudatus.	*Orthezia praelonga.*

This is a small total, but the fact that such a pest as *Aulacaspis pentagona* or *Orthezia insignis* has escaped and infected distant places, doing serious damage, is in itself

sufficient to call for strict measures to guard against this. The West Indies have received far more than they have given, in species of scale insects and in loss, but this may not be so in the future with increased means of communication and other facilities for the spread of insect pests. The object of this paragraph is briefly to point out the danger of importing plants from the West Indies without proper precautions, and to emphasise the very great necessity of the adoption in England and the whole British Empire of adequate measures against the increasing spread of hurtful species of scale insects.

The matter has been dealt with as regards these Colonies in these pages and a practical realization of such measures in these islands is probably a matter of the near future.*

WILD AND CULTIVATED SPECIES.

A naturalist arriving at an island such as Dominica would, if his attention were directed to the *Coccidae*, observe that these insects were as common in the gardens and streets of the towns as they were rare in the forests or uncultivated waste lands outside the limits of cultivation. This is not the less striking in an island such as Barbados where there is very little uncultivated land, where the whole island is densely cultivated and populated, and there are but traces of the original forests or waste lands. Throughout Barbados, scale insects may be found on the plants grown for food, for fruit, or for ornamental purposes. But in the little bits of woodland such as are found at Turner's Hall or Newcastle, the trees are healthy, not covered with black blight or spotted with scale insects. The collector here finds perhaps one species of Coccid after prolonged search, and that proves to be one of the native West Indian species not found usually on cultivated plants.

What is the explanation of this fact?

We can find no full explanation and can only hazard theories. I am of the opinion that, taking a list of the species that grow on wild uncultivated plants, we find two classes: native species which may or may not confine themselves to wild or to native plants, and introduced species which have not confined themselves to cultivated plants.

Considering the *Coccidae* of any one place as a whole, on the one hand, there are native species, accustomed to live on wild or acclimatized plants, and on the other hand, there are the introduced scale insects accustomed to live on these introduced plants.

These tend to keep separate, the native species on the wild plants, the introduced species on the introduced plants grown in cultivated areas; but they may spread into each other's domains. This is more likely to take place in the case of native species which find the cultivated plants weak from struggling against unnatural conditions and so make them an easy prey.

* *West Indian Bulletin*, Vol II, p. 318, and Vol. III, p. 140.

rather than in the case of the introduced species, which must accustom themselves to the vigorous wild plants in order to obtain a footing outside the region of cultivation. If this reasoning be true, our wild species will be native species with such introduced species as have wandered in from cultivated land. Now, wild species, that is, species living on wild plants in waste or virgin land, are not common. In the course of a considerable amount of wandering over these islands I have seen but few of them, and I have made special efforts in every case not to miss an opportunity of recording these wild species. Here and there, one meets with most interesting cases: thus in St. Lucia, I found a small patch of Liberian coffee, at an elevation of 800 feet, forming part of an estate surrounded by either virgin forest or waste land (land many years out of cultivation). These coffee trees were covered with *Aspidiotus articulatus* and *Ischnaspis filiformis*, yet neither of these insects could be found anywhere else in the neighbourhood. Why did not these *Coccidae* spread to surrounding plants, as they do so constantly where there are a variety of cultivated plants? This isolated case, of which I have seen many examples, inclines me strongly to think that it is hard for an introduced species to live on anything but cultivated plants, or for a 'cultivated' native species to again return to wild plants. But Coccids are always less common on wild plants than on cultivated ones, which, I am convinced, is a matter of 'vitality.'

The following list includes the species I have found on wild plants as apart from cultivated ones:—

Aspidiotus articulatus.	4	wild plants.
„ *sacchari.*	1	„ „
„ *cydoniae.*	1	„ „
„ *destructor.*	3	„ „
„ *personatus.*	1	„ „
Aulacaspis pentagona.	5	„ „
Chionaspis minor.	6	„ „
Ischnaspis filiformis.	1	„ „
Pulvinaria urbicola.	2	„ „
Protopulvinaria pyriformis.	4	„ „
Ceroplastes cirripediformis.	2	„ „
„ *Dugesii.*	1	„ „
Lecanium hemisphaericum.	3	„ „
„ *hesperidum.*	2	„ „
„ *longulum.*	1	„ „
„ *nigrum.*	2	„ „
„ *oleae.*	3	„ „
Dactylopius citri	2	„ „
„ *virgatus.*	1	„ „
Asterolecanium bambusae.	1	„ „
„ *pustulans.*	3	„ „
Coccus tomentosus Newsteadi.	1	„ „
Orthezia insignis.	2	„ „
Pulvinaria, sp.?	2	„ „
Icerya, sp.?	1	„ „

This is a total of only fifty-eight cases, comprising twenty-three species of *Coccidae*. The foodplant and locality records for the *Coccidae* of the smaller islands comprise several hundreds, the above cases scarcely constituting one-twentieth of the whole number. We now return to our original point of why this should be the case. The above fifty-eight cases contain instances such as *Aspidiotus sacchari* on Bahama grass, a native species on a wild plant, and *Lecanium hemisphaericum* on *Barleria*, an introduced scale running wild on a wild plant. Similarly, there are many cases of both native and introduced species on the cultivated plants. But the attacks on cultivated plants are always far more numerous than on wild plants, and introduced species 'run wild' on cultivated plants continually, whilst they very rarely do so on a wild plant. One factor certainly is in the state of the plant. Any plant growing wild must be vigorous to have withstood the competition of the other plants; it is living under natural conditions, more or less well suited to it. But a cultivated plant is forced to grow where it is placed; there is no competition; it may be in adverse circumstances and is artificially maintained in growth. The result often is a lack of the vigour that characterizes native or wild plants, and this exposes it to the scale insect attack as it does to some other forms of disease.

Another factor probably consists in the adaptability of many introduced species of feeding on a variety of foodplants. Every additional foodplant is a help to further increase and spread, and introduced species seem to possess that adaptability or to acquire it. There is also the fact that species confined to one plant have far less chance of being introduced than do the virulent species which are capable of living on a variety of plants, and naturally, it is the latter which are brought in with plant importations.

COCCIDS AND ANTS.

Ants are a very constant accompaniment of many species of *Coccidae*, so much so that many people credit the ants with the damage done by the scale insects. They over-run the trees infested with some scale insects, visiting them constantly, and it is not hard to imagine that the ants may be a powerful factor in the spread of *Coccidae*, and in preserving them from enemies. Observations on the precise degree of the relations between them would be of great value, though they would necessitate very prolonged observation under difficult circumstances.

In collecting *Coccidae*, one frequently sees ants pick up the young scale insects in their jaws and carry them off: they will do this immediately a scale insect is killed or injured, and frequently pick up the live ones when the whole colony is disturbed or removed from the plant. But I have never seen this occur under normal circumstances, nor have I been able to show that the ants carry the eggs or in other ways help the scale insects. They remove the mealy wax in some cases, and appear to feed on the 'honey dew.'*

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* *West Indian Bulletin*, Vol. II. p. 346.

A small mahogany tree infested with a *Lecanium* was isolated by painting a ring of 'dendrolene' round the trunk, in the hope that the ants on the tree could not return to the nest but would die speedily.

The ring of dendrolene effectually isolated them, but they lived apparently unharmed on this tree for several weeks, sheltering under loose flakes of bark, and apparently subsisting on the excretion of the scale insects. Further observations on this point are in progress, but I have little opportunity for this work and it would be a useful investigation for some observer.

The species that ants will follow are well defined and are identical with the species that cause 'black blight.' This blight is the sooty fungus that apparently lives on the sweet excretion of the Coccids which falls on the leaves below. The presence of black blight is the common accompaniment of the attack of certain *Coccidae,* just as the presence of ants is usually diagnostic of the same thing.

The species that ants will follow are included in the genera *Pulvinaria*, *Ceroplastes*, *Lecanium*, *Dactylopius*, and *Margarodes*.

I have not observed them visiting other genera.

There are exceptions in the above genera: thus *Ceroplastes cirripediformis* is not an 'ant' species, though *C. Dugesii* is. The same is true of a *Lecanium* n. sp. found on sugar-cane, though all our other *Lecanii* are visited. *Dactylopius virgatus* does not appear to offer attractions to ants.

With these exceptions, all the species of these genera found in the smaller islands are characterized by the visits of these ants (which sharply bite the collector and observer), and also by the black blight.

The remaining genera and species do not appear to excrete honey dew in the way that these do.

HABITS.

Locomotion. Coccids vary considerably in their degree of activity. The *Diaspinae* are perhaps the least active and move very little, for except when just hatched, they appear to be incapable of moving, and having once fixed their rostrum into the plant, they commence scale formation and do not then move. Almost the same is true of *Ceroplastes* and *Vinsonia*: the wax commences to be produced very early, and after this, they do not migrate from their original location.

The *Lecanii* are far more motile and some more so than others. *Lecanium oleae* is one of the least active, but such forms as *Lecanium longulum*, *mangiferae* and *hesperidum* can become active up to the time of gestation. The same is true of the *Pulvinariae*, though they will not move after the ovisac commences to be formed. The *Asterolecanii* are less active, resembling the *Diaspinae*, and this may be due to the glassy covering they secrete.

The *Dactylopii* are active up to the time of oviposition, and *D. virgatus* will walk at any time, as it forms no ovisac

and is almost ovo-viviparous. *D. calceolariae*, perhaps owing to its unwieldy bulk, finds difficulty in locomotion after it is mature, but it is exceptional. *Ceroputo Barberi* is another active species, walking vigorously at slight provocation at almost all times. *Orthezia* and *Icerya* are active throughout their lives in most cases and the former genus markedly so. Probably this power of extended locomotion is a considerable help in spreading from place to place, but the means of dispersal are peculiarly difficult to understand in the case of these small insects.

In *Orthezia* and *Icerya* the legs are more fully developed in relation to the rest of the body than in our other genera, the legs in *Dactylopius* and *Lecanium* appearing to be very inadequate for locomotion over any distance.

Location on the Plant. Other habits are not easy to observe, but in a few cases there are points of interest. The habit possessed by *Dactylopius brevipes* of entering the 'eyes' of the pine and becoming enclosed there by the bracts is very singular. The mature insect can rarely escape in the case of such pines as the Black Antigua, in which the eye closes very tightly, though the young which hatch inside can and do escape between the bracts. *Vinsonia stellifera* is curiously fond of placing itself on the 'veins' of the leaves it infests, and in the case of large-leaved plants this may be very obvious, the secondary veins being marked out by the lines of little glassy scales on them.

Many other species prefer the main veins of the leaves, collecting beside the midrib in considerable numbers, but in other cases the insect settles down without regard apparently to its position on the leaf. Most leaf-infesting species prefer the lower shaded side, but *Aspidiotus articulatus* in particular is found on the exposed side, as also *Pinnaspis buxi* in many cases.

Coccids infest all parts of the plant, and some species are confined to certain parts. Many are found only on the bark, others on the leaves and fruit, and a few of our species are underground. Thus *Aspidiotus sacchari* lives on the underground rhizomes of the Bahama grass, though it also lives on the stem of the cane. *A. Hartii* is found on the yam below the ground.

Pulvinaria urbicola infests every part of the plant from the root upwards, as does also *Icerya rosae*, though the latter rarely goes below the surface. *Margarodes formicarium* is a purely root-feeding species, found some depth below the surface.

Broods. In almost every case there are no regular broods, insects of all ages occurring together at once. In cases where a few only of a species are introduced to a new locality, there may be a whole brood of nearly one age, but this is speedily lost in the succeeding generations, those that first hatch and develop most quickly outstripping the others.

Egg-laying is so comparatively long in some species, and the subsequent development so rapid, that it is not uncommon

to find the offspring of one parent comprising young mature scales and newly hatched larvae. There are, in consequence, in every colony insects in all stages of development. Notable cases are found in a few instances.

In *Aulacaspis rosae* the colonies consist each of one, two, or three females, with a larger number of males, grouped together on a leaf. In these the male scales are usually of the same stage, all being immature or fully mature, with little apparent difference between them.

In the case of *Ceroplastes ceriferus* and *C. floridensis*, the development is slow, and there is little difference between the degree of development of the waxy covering, all appearing to be somewhat of the same age. This is not invariably true, but is far more marked than in the case of other scale insects.

Another point in which Coccids differ is their gregariousness: some are peculiarly gregarious, forming dense colonies which gradually spread. Notable cases are *Aspidiotus destructor, A. aurantii, A. dictyospermi, A. ficus, Aulacaspis pentagona, Diaspis calyptroides, Chionaspis, Mytilaspis, Pinnaspis, Lecanium hemisphaericum* and *L. nigrum* and some others. These collect together, in some cases tightly packed, the males, when they occur, wedged in with the females.

Diaspis Boisduvalii on cocoa-nut has a habit of forming a dense colony of males and females in one spot, perhaps an inch in diameter, and it is only on these spots that *Aspidiotus destructor* will be found if both scales occur together on the plant. The discolouration of the spots enables one to locate the colonies very easily, and it is unusual not to find both species together.

Other species are more solitary, some particularly so: thus *Aspidiotus articulatus* usually occurs scattered over the leaf, as does *A. personatus. Pulvinaria ficus* is usually difficult to get in any number without collecting a mass of foliage, as also is *Lecanium mangiferae*. The remainder have less distinctive habits, the degree of crowding often depending on the number present.

ASSOCIATED SPECIES.

In a recent paper Mr. King discusses the 'Association of *Coccidae*,' simply recording cases where various species are found living on the same foodplant.* This is a matter of such constant occurrence in the West Indies that hundreds of cases could be cited, and a very large number of plants are constantly affected by several species. There is no connexion between the species other than that they both have the same foodplant, and one looks in vain for any instances where two species are in any closer way associated. In one case alone I have found what appeared to be some relation between *Diaspis Boisduvalii* and *Aspidiotus destructor*, in that, on the cocoa-nut palm in Barbados, the latter only occurs amongst the colonies of the

* *Psyche*, October 1902, p. 401.

former. The *Diaspis* lives in compact colonies on the leaves, and only in these spots is the *Aspidiotus* to be found on this palm. This may be chance, or it may be the young *Aspidiotus* prefer to fix themselves in the shelter of these compact colonies.

On looking up the ordinary cases, I find that certain species are very constantly associated. Thus *Lecanium hesperidum* and *Lecanium hemisphaericum* are frequently together on a plant, as are *Lecanium nigrum* with *Chionaspis minor*, and *Asterolecanium pustulans* with *Chionaspis minor*.

FOODPLANTS.

In the West Indian islands, plants of all kinds are attacked by scale insects, and in the course of continual observation of scale insects and their foodplants, certain relationships between these two have come to light. These islands are particularly favourable to this work, as not only do a large number of plants grow wild in this tropical climate, but many plants have been brought from distant localities and are grown in gardens and, under as far as possible natural conditions, at the Experiment Stations and Botanic Gardens. There is then a large variety of plants growing freely in localities infested with a large number of indigenous and introduced species of scale insects. Regarding the matter from the point of view of the scale insects, it is found that for each species there is a varying number of plants that fall into three irregular series, namely, 'habitual foodplants,' 'semi-habitual foodplants,' and 'occasional foodplants.' Of these series the 'habitual' are as a rule fairly well marked. For instance, lime, sweet orange and grape fruit are habitual foodplants for *Mytilaspis citricola*, this scale infesting every specimen of these trees in a locality to which it has once been introduced. Mandarin and tangerine orange are sometimes attacked by this scale insect, but in some cases, these trees, growing with lime or sweet orange, are not affected by it. These I regard as semi-habitual foodplants. I know of no occasional foodplants for this scale insect.

Again *Dactylopius dubia* in these islands habitually infests cocoa-nut palms; I have also found a cocoa-nut palm overshadowing cacao trees in Grenada where the trees immediately under the cocoa-nut palm were also attacked. In no other case have I seen this mealy bug on cacao, and this plant is thus classed as an occasional foodplant. *Dactylopius dubia* seems able, under certain circumstances, to live on cacao trees.

Regarding the matter again from the point of view of the plant, for many plants there are three series of scale insects,—those that are always found on that plant when once introduced, those that occur occasionally, and those that are found once only and seem unable as a rule to live on that plant. Thus, for the lime tree, *Chionaspis citri*, *Mytilaspis citricola* and *Aspidiotus articulatus* are habitual pests. *Lecanium hemisphaericum*, *Lecanium hesperidum* and *Lecanium oleae* occur frequently; not always even when present, but each has been

recorded so often that it is evident that they can all live on it. Finally, *Orthezia praelonga* has once been found infesting a single field of lime trees; as a rule it will not attack the tree, though it may constantly be found on Barbados cherry trees or other plants growing with lime trees. This may be regarded as an occasional pest only.

It is evident that it is difficult to separate the semi-habitual from the occasional, but there are so many well-marked cases of each, that these divisions appear inevitable. Possibly the occasional foodplants are always in bad health or weak, offering an easy prey to scale insects, for scale insects attack their habitual foodplants with far more effect if the latter are sickly; and the chance of finding 'occasional' pests on any plant is much greater when that plant becomes weak through drought or other causes.

The question of foodplants of scale insects is to some extent analagous to that of *Lepidoptera*, with the great difference that whereas *Lepidoptera* can in their mature stages move about, often over considerable distances, scale insects can do this but little. The locomotion of scale insects is confined to the newly hatched young in many cases, in others to both sexes in all stages: but this locomotion is always by walking, unless carried out by a chance bird or breeze. One might then expect that from one infested foodplant, scale insects would migrate to neighbouring ones, and would in every case attack them, since the chance of finding the same plant would often be very remote; but Nature does not appear to allow the scale insects to adapt themselves to any plant, and in many cases, when the original foodplant is killed, enormous numbers of young scale insects hatch out and then die for want of a suitable plant close by. This, naturally, has a great effect on the spread of these pests, since a scale insect that has but one foodplant is very much handicapped by circumstances.

Such a pest as *Aspidiotus destructor* is abundant chiefly on account of its great range of habitual and semi-habitual foodplants: its occasional foodplants are also numerous, and its destructiveness is consequently great.

There is an interesting point in connexion with the change of foodplants in different localities. In America, as in parts of Europe, *Aspidiotus aurantii* is a common pest of citrus plants, (lime, orange, etc.) In the West Indies, its habitual foodplants seem to be *Hibiscus esculentus*, and only once have I obtained it from citrus. Similarly, *Aspidiotus ficus* in the United States, is a pest of citrus plants; in the West Indies it attacks screwpine, roses, palms; but the only case of attack on citrus plants recorded is on two young grape fruit trees, recently imported, probably with the scale on them.

Again there is the case of *Lecanium tesselatum*. It is found in Barbados on *Caryota urens* only; in Montpellier on the same plant (Signoret), in Ceylon also (Green), in Harvard, Massachussets also (King), and in Grenada also, as well as Jamaica (Ckll.): but in Jamaica it occurs on other plants, as also in Grenada, Harvard, Jamaica; and Maskell mentions it on

Laurus in Australia. Doubtless it spreads about on *Caryota*, here and there breaking out on other plants, but almost always sticking to its *Caryota*. In Barbados this is most marked, the insect being common on *Caryota*.

Again there is *Aspidiotus articulatus*. I have never seen it on palms. Cockerell says, in Jamaica, 'a serious enemy of palms.' Yet the insect is abundant in the West Indies, occurring on plants near palms continually, but not on the palms themselves.

MALES.

Male scales are rare or absent in a large proportion of the West Indian *Coccidae*, and probably this proportion is a larger one than in any collection of *Coccidae* from temperate regions. This is possibly due to the entire absence of any cold period. The uniformly high temperature and equable climate do not call for any periods of rest, nor is there any season of especial mortality from climatic causes. It is not certain that these considerations affect the occurrence of males, but we may, reasoning by analogy from other groups such as *Aphidae*, at least mention the facts as a possible explanation. Males occur in the following species:—

Aspidiotus ficus	...	plentifully.
„ *biformis*	...	equal number.
„ *destructor*	..	few.
Diaspis Boisduvalii	...	more males.
„ „ var. *maculata*	...	equal number.
„ *calyptroides*	..	more males.
Aulacaspis pentagona	..	equal number.
„ *rosae*	...	more males.
Chionaspis citri	...	„ „
„ *minor*	...	„ „
Mytilaspis citricola	...	„ „
„ *Gloveri*	...	„ „
Pulvinaria urbicola	...	few.
Lecanium nigrum	...	„
„ *oleae*	...	„
Dactylopius adonidum	...	„
„ *calceolariae*	...	„
„ *citri*	...	„
Pseudococcus tomentosus Newsteadi		more males.
Icerya rosae	...	equal number.

This gives a total of only thirteen in which males occur commonly, and seven in which they have been observed, in the Lesser Antilles. Doubtless there are other species in which the males occur rarely, but have as yet escaped observation.

The absence of the males would appear likely to be a great factor in the rapid increase of any species. If the entire progeny is female, there is a larger number of egg-producing individuals in each generation than in a case where many males are produced. The large proportion of males found in *Aulacaspis rosae* is an obvious check to rapid increase, and may in itself be sufficient to account for the slower increase of this species.

ENEMIES ('PREDATORS').

Scale insects are here, as elsewhere, attacked by a variety of organisms, distinct in their method of attack from internal parasites.

Mr. Newstead has drawn attention to birds as enemies of *Coccidae*. I have had few opportunities of observing the birds, except in Barbados; and in the latter colony birds are not abundant, and few in species. I have evidence only of two small birds eating *Coccidae*, but I have been able to verify this so frequently from observation that I have no doubt it is the case. Small birds are so scarce however in Barbados that I question whether any appreciable amount of destruction is caused by this means.

Predaceous insects are far more effective in checking the scale insects.

These include the larvæ of *Chrysopa*, a variety of *Coccinellidae*, some *Diptera* and some *Lepidoptera*.

The *Chrysopa* larvæ are infrequent enemies of *Coccidae* but they attack the sugar-cane mealy bugs and are frequently very abundant, feeding also on the cane fly, *Delphax saccharivora*.

The *Coccinellidae* occur more frequently. There is here a large field for study which may offer good results when more fully undertaken. So far as is known at present, the different species are very local in their distribution.

Exochomus nitidulus Fabr. occurred abundantly in St. Lucia, attacking *Mytilaspis citricola*. Some were sent to Montserrat and set free on lime trees, but were at once eaten by lizards. Others were kept in captivity in Barbados but would not lay eggs, so these attempts to spread them failed. Since then, the beetle has very much increased in its former locality in St. Lucia.

Exochomus circumdatus Muls. is an enemy of *Phenacoccus Barberi* in St. Lucia. The larva is covered with white mealy processes, closely similar to those of its prey and pupates under its cast skin; it is therefore difficult to find, both the Coccid and the grub being active.

Dipterous larvæ (*Cecidomyidae*) are found eating the eggs of *Lecanium nigrum*, *hemisphaericum* and *oleae*, and of *Pulvinaria urbicola* under the scale of the parent Coccid. These are responsible for a great destruction of the insects.

In Grenada, *Lecanium punctatum*, and in St. Kitt's, *Lecanium oleae*, are attacked by a caterpillar which covers the infested twigs with webbing and lives underneath, feeding on the scale insects. It subsequently spins a tough cocoon and pupates on the same spot. Probably this is one species, but specimens were reared only from the St. Kitt's specimens. This insect may be more widespread, such webbing being frequently found on twigs badly infested with *Lecanium*, though the caterpillars themselves were not found.

PARASITES.

Minute *Hymenoptera* whose larvæ live in the bodies of *Coccidae* are frequently found infesting a considerable percentage of the members of a colony of scale insects, and though these parasites have been but little studied in the West Indies, enough has been done to show that they play a considerable part in checking the spread of several species. There are two simple methods of finding whether these insects are playing any part in the destruction of *Coccidae*: to prepare and mount the scales as microscope slides for examination, and to keep the colonies in muslin-covered jars till any parasites emerge. The latter affords a rough method of ascertaining what percentage of scale insects contain parasites.

So far it has been found that parasitic *Hymenoptera* play a very considerable part in the life of several species of *Lecanium* and also of *Pulvinaria*, but that they are of far less importance in other genera. As many as 90 per cent. of *Lecanium nigrum* may yield parasites, and the same is sometimes true of *Lecanium hesperidum* and *L. hemisphaericum*. The question of the importance of these parasites deserves to be carefully studied, with a view to determining the real value of spraying in cases where the scales are infested with parasites. Miss A. L. Embleton has recently studied the parasitism of certain *Chalcididae* chiefly on *Lecanium hemisphaericum*, var. *filicum*, and says :* 'I am led to rate very highly the value of these parasitic *Hymenoptera* as destroyers of Coccid pests. . . . . . 'If they (internal parasites) are found in large proportion, then the application of a remedy should be abandoned. If they are present in a smaller proportion, then time should be allowed before any insecticide be used, so that the parasites may emerge from all those individuals containing them.'

This is the suggestion of a writer who has carefully studied the parasitism as a phenomenon, irrespective of the practical bearing of the subject as met with by economic entomologists. Possibly, under the conditions this writer met with, the parasites emerge at a definite period so that at a certain time one could find the scale insects without parasites, these being represented by the adult insects flying about. Under these circumstances, spraying could be adopted without any fear of destroying parasites, provided the right time is chosen. In the tropical climate of the West Indies, there is no such period. Parasites are constantly emerging, and there is no recurrent life-history period common to a large number of insects. Hence spraying at any time is liable to kill parasites. But, the life-histories of the parasites being here shorter than in a cold climate, it is found that though the scales are sprayed and killed, a large number of parasites will still emerge. Presumably these are those already in the pupal stage, or near to it. There is therefore less danger in spraying scale insects here. Apart from theory and hypothesis as to the effect of spraying on parasites and so on the increase of the scales, what results are obtained in practice?

* *On the Economic Importance of the Parasites of Coccidae.* Transactions Entomological Society, London, 1902., p. 219.

The writer has had occasion to treat many hundred cases of scale insects in the West Indies, often under most favourable conditions for studying effects, and experience shows that, as a rule, under conditions obtaining in these islands, it is useless to rely on parasites. The conditions favour continual increase of scale insects; there is no winter or resting period, and both parasite and host can go on indefinitely multiplying. With one exception, not one species is known to be checked by parasites and 'predators' combined for a period lasting so long as six months. The exception is *Pulvinaria urbicola*, a common pest that rarely becomes destructively abundant, and never appears to remain so. It is attacked by *Chalcididae*, by Coccinellids and by an egg-eating Cecidomyid larva, and does undoubtedly seem to be checked by these.

It is useless to wait for parasites to check and keep in check any other species of the commonly destructive scale insects studied here. Spraying must be resorted to, if these pests are to be kept within limits. In some species, there seem to be certain limits beyond which they do not increase, but these do not come within the limit where no damage is done to the plants. Possibly the scarce species are really checked by parasites or predators, but well established species are continually and constantly troublesome on the same plants in the same localities.

It would be a great thing to bring the parasites within the scope of practical entomology, as the *Coccinellidae* have, to some extent, been. Beyond not spraying scale insects, there seems no way of materially helping the parasites to maintain just the numbers necessary to keep down the scales. Perhaps this also may be achieved, and the future studies of this question may reveal a practical method of keeping down *Coccidae* by encouraging their parasites as much as their 'predators.'

DISEASES.

Fungoid diseases are occasionally responsible for a great mortality among *Coccidae.*

Lecanium hemisphaericum is killed by a fungus, which subsequently forms a matted white growth on and around the scale. This appears to take place only when the scale is in a damp situation, or during very wet weather. It is far more common in Grenada than in Barbados for instance, the latter being a drier climate. *Lecanium hesperidum* also suffers in a similar way, as also does *Lecanium mangiferae.*

The sugar-cane mealy bug is attacked by a disease, which subsequently forms a yellow cottony mass on the dead insects.

These fungi have not as yet been investigated. It is possible that a careful use of them in wet weather would assist in the checking of these scale insects, but the matter has not as yet been carried out in practice.

THE PLACE OF COCCIDAE AMONG ECONOMIC INSECTS.

Coccidae are extraordinarily abundant in the West Indian islands, being found on a surprising variety of plants in very large numbers. In Barbados, during the dry season especially, it is no uncommon thing to find every tree and bush in a garden infested to some extent, a large proportion of these plants showing very evident marks of the attack either by a liberal coating of 'black blight' on the leaves, or by the withered appearance of the branches. Where trees grow wild this is not so much the case as in the case of cultivated plants, and I failed to find more than one species of Coccids in the few remaining portions of wild forest in Barbados.

In and around the towns in all these islands, specimens of the common Coccids can be obtained with the greatest ease. Comparatively few species are represented, but such as are there occur in vast numbers. In many islands one can rarely find a mango tree not covered in 'black blight,' or a cocoa-nut palm free of disease, save when one rides to the hills and mounts above the lower levels near the coast.

There is a fairly constant, yearly variation in the case of many species, dependent on the season, or in the case of Coccids on particular plants, dependent on the falling of the leaf. During the wet season, the evidences of scale insect attacks lessen, some species being killed off by disease, others apparently decreasing in number for other reasons. It is not always an actual lessening in numbers, but the attacked plants are in fuller vigour, put out new leaves, and do not suffer to so great an extent as at other times. Some trees like the frangipani (*Plumeria*) shed their leaves yearly. This tree is peculiarly susceptible to scale insects. New leaves come out early in the year and the handsome foliage and bright blossom make it an especially beautiful tree. Then, as the dry weather sets in and the scale insects are on all the leaves, black blight covers over the whole tree, and all plants underneath, and presently it becomes far from ornamental. The leaves then dry up and fall gradually, a few Coccids remaining on the ends of the branches, and with the new year it stands bare and blackened, awaiting fresh foliage and a fresh crop of scale insects. Other plants, having no yearly fall of leaf, are infested more or less according to the season. The cocoa-nut palm is a good instance, it being rarely seen without evident signs of the attack. The young leaves come out fresh and green, and instead of drying up and falling off as in the case of healthy trees, they turn yellow, the lower half of the crown of leaves being usually in this condition. The trees then are most unsightly, very different from the ever fresh and healthy appearance of palms that are not thus diseased. Generally speaking, the majority of the trees, plants and shrubs in any garden or orchard in these islands suffer more or less permanently from scale insects. As general pests they outclass all other insects together. Without them, very many valuable plants would yield a far larger quantity of fruit or other products, and some trees now grown with difficulty would thrive and flourish. The damage to citrus plants throughout the Lesser Antilles,

with the exception perhaps of Dominica, is very considerable, and the same applies to mango and many other common plants.

Scale insects are the external 'parasites' of plants just as ticks, etc., are of animals. They continually seize the plant life and drain it of its vigour or whole life, or more often rob it of all but vegetative vitality. Rarely they kill plants outright in a speedy manner, as a caterpillar does. More often it is slow destruction that never prompts remedial measures in the mind of the planter, and that takes favourable circumstances to be overcome when remedies are adopted. Throughout the year scale insects attack plants, and the spraying machine may be required at any time to meet a new invasion.

Only those who have experienced them in a tropical or sub-tropical climate, can realize the extent to which cultivated vegetation suffers from the attacks of these, the worst enemies to plant life in the West Indies.

PLANT SPECIES.

Are there such things as plant species that is, Coccids regarded as of distinct species owing to anatomical characters, but in which differences are produced by the difference in the character of the plant or its sap? Would it be possible to produce two 'species' from one by growing them on different foodplants? There is much to favour the belief that this is possible. Coccids have little chance of much selection in foodplants; they cannot wander far in search of the same plant as their parents lived on; and failing to find that, may settle on other plants and conceivably become altered in character. Again, the specific differences between the species of such genera as *Asterolecanium*, *Lecanium*, *Pulvinaria*, *Dactylopius* are frequently so minute, that the opinions of even careful systematists are not infrequently at fault, and very slight changes are required to transform one species to another.

In the *Diaspinae*, the characters of the pygidium are largely used in classification; the lobes, squames and glands are to the insect of use in the formation of the scale, and the character of this scale is a very variable feature. Might not this variation of the scale be correlated with a variation of the pygidial organs, sufficient to give what would appear to be a valid species? In considering geographical distribution and allied questions, the identity of our species and their validity is of such importance that this point may be of value. One frequently finds a colony of scale insects apparently differing from all others found there. The tendency is then to describe a new species. No one can check the description or upset the validity of the species unless specimens are to hand. The distinctive marks of the species are naturally dwelt upon, and possibly, unconsciously magnified, as they are uppermost in one's mind. A new species then appears. Yet if one keeps the specimen undescribed, it is not impossible to find that it shades into a well-known species: one gets a series linking the two, and the new species, if undescribed, is abandoned.

In studying Coccids, one is driven to believe that there are 'plant species,' and it would be a nice problem to produce

such 'species.' Experiments in this direction are at present in hand, but the work demands the assistance of an authority on the group, the differences produced, sufficient to differentiate closely allied species, being very small.

CONTROL.

Scale insects may be regarded as being, on the whole, the most destructive group of insect pests found in the West Indies, and a very grave problem arises in the question of limiting, as far as possible, the destruction they give rise to. This question forms part of the whole question of 'Insect Control,' which was fully discussed in the *West Indian Bulletin*, Vol. II, p. 318.

Obviously, the first necessity is to limit the problem as far as possible by preventing the introduction of fresh species, and the value of this is patent to everyone. For the West Indies, this is probably a question of time, and Jamaica has for some years taken practical steps to deal with it. The measures likely to prove useful for the West Indies are discussed in *West Indian Bulletin*, Vol. III, p. 140.

There remains the question of dealing with the species now found in every island. Practically these are distributed throughout the cultivated regions on the common fruit trees, garden plants and vegetables. Staple crops such as lime, sugar-cane, cotton, pine-apple, pigeon-pea, Central American rubber, etc., are also infested. The area to be treated may be large and the problem becomes a serious one. It is found that periodically these scale insects do an amount of damage sufficient to call for treatment to such an extent that planters and others would wish to adopt some measures; whilst at other times, the damage not being very apparent, those responsible for the affected plants do not care to take any steps. These periodical outbreaks are not regular, though they depend largely on the alternation of wet and dry seasons, and it is consequently impossible to predict when any outbreak will occur of sufficient intensity to become obvious to the public. Under these circumstances, it seems that the checking of the scale insects is a question of adopting strong remedial measures, once or twice a year, regardless of the outbreaks and the conditions that cause them. In Barbados, where there have been many opportunities of observing the results of treatment, thorough spraying of every infested tree and plant in a restricted area such as a garden gives the best results if carried out at the close of the rainy season, about November. A comparatively large area of plants can be kept in good health by carrying out a thorough treatment, three sprayings, at intervals of a week, once a year.

There may arise occasional exceptional outbreaks, such as when *Dactylopius virgatus* 'runs wild;' but these are easily met, if seen in time.

Apart from fumigation, which is impracticable in these islands at present, regular spraying alone gives satisfactory results.

Attempts have been made simply to spray each plant

whenever it needed it, only treating those badly infested. This is unsatisfactory, entailing far more work and a far larger quantity of wash in the course of a year.

If everyone adopted regular spraying, there is no doubt that the scale insects would be kept in check; and it seems better to put the responsibility on individual persons, than to carry it out on a large scale.

Besides the spraying, there are other necessary precautions. The chief is to keep one's plants in vigorous health, and since this is impossible in the case of many exotic plants during the dry season, it would be better to grow only such plants as can stand the conditions fully. Weak plants are an inducement to scale insect attack. Scale insects would undoubtedly be much less frequent if only those plants that suit the conditions were grown, and the most prolific source of scale insects is the Botanic Garden where tender exotic plants are grown under unsuitable conditions.

Another precaution consists in not growing certain plants which, though they may thrive, are always attacked by scale insects and form centres of infection. Such are the frangipani *(Plumeria)*, the guava, the oleander, several species of *Cordia*, etc. These should not be grown, or if they are, they should be sprayed at least every three months.

Another simple precaution lies in not planting out scale-infested species. It is in this way that the various species are spread.

Beyond this there is little to do. There is as yet no practical method of encouraging the 'predators' other than by not destroying them in ignorance. Parasites cannot be helped to do their good work. Small birds can be encouraged and may do useful work.

The maxims for successful work against scale insects, whether on a whole island, an estate, or a garden, are, after all, only the few commonsense suggestions: Spray regularly and thoroughly, at the right season. Grow only strong, healthy plants and keep them vigorous. Do not introduce fresh species of scale insects. Take special precautions in a very dry season and be prepared to do extra spraying. Encourage birds and 'predators.'

It may be said that this requires an expert to direct, and that a host of entomologists will be needed to make this effective. I am of opinion that a person of average intellect, who is willing to take an interest in other matters that concern the growth of plants, is fully able to make the necessary wash, and see it applied at the right time. The function of the entomologist is simply to explain the details the first time this work is undertaken, and to recommend washes, spraying machines, etc. Spraying machines must be bought to suit local circumstances, as also washes must be adapted to particular scale insects and trees. In these islands, the best results are obtained with rosin washes for *Diaspinae* and *Lecanii*, with kerosene emulsion or whale oil soap for *Dactylopius* and similar insects, and with a combination of whale oil soap and rosin compound as a general all-round wash.

A new compound of crude oil, napthalene and whale oil soap has been recently tested and gives very good results on all but *Lecanii* and some *Diaspinae*. Further information is published regarding this wash in the following pages. All washes used must be similar to those used in summer in temperate climates. Winter washes are here too strong as a rule. Kerosene mechanically mixed with water has given good results, but the special machinery needed is not compensated for by any advantage over the ordinary emulsions. Crude oil such as is obtained in Barbados is specially suitable owing to its greater density and viscosity, but it cannot be applied with a Kero-water or other double-pumping machine, as it will not mix with water.

Excepting the 'whale oil soap and rosin compound,' and the very useful 'crude oil and soap compound,' no new mixtures have been devised, and the ordinary 'summer washes' used in America are equally useful here.

Fuller information as to the details of treatment recommended and used in the West Indies is to be found in the pamphlets *Scale Insects of the Lesser Antilles*, in two parts, issued by the Imperial Department of Agriculture.

CRUDE OIL AND SOAP, A NEW GENERAL INSECTICIDE.

BY H. MAXWELL-LEFROY, M.A., F.E.S., F.Z.S.

Entomologist to the Imperial Department of Agriculture for the West Indies.

Amongst the most valuable of the insecticides employed against sucking insects is kerosene, used in the form of emulsion with soft or hard soap, or, more recently, in mechanical mixture with water alone. Kerosene has a specific action on insect life, of which no very clear explanation has as yet been offered, and the mere contact of this oil with the bodies of many insects is sufficient to destroy them. For many years now, kerosene has maintained a foremost place amongst the substances used to combat scale insects, aphides and other pests, though it is, to some extent, replaced by whale oil soap. Perhaps the chief objection to kerosene, or as it is known in England, paraffin, is its cost. In the West Indies this is a very important point, kerosene costing from 16 cents per gallon in Antigua to 30 cents per gallon in Barbados. In the United States for the past three years and more, 'crude oil' has been tested with a view to substituting it for kerosene. Crude oil is petroleum as obtained from the ground, with a slight amount of refining

or purifying, kerosene being one of the products obtained in further refining: it is, in fact, kerosene with a varying proportion of kerosene oils and bodies similar to vaseline and paraffin.

It has been stated that the presence of these heavier oils and more viscid bodies would give the oil better insecticidal properties, and the crude oil would naturally cost less per gallon and possibly be used in less quantity proportionately. At the present time, so far as can be judged from the reports received from entomologists in the United States, crude oil is partially replacing kerosene in the winter treatment of scale insects on fruit trees, and appears likely to be a useful insecticide when its properties have been more fully tested and experience has confirmed its usefulness.

We may quote the words of two authorities in the United States to illustrate the opinions held there as to the value of crude petroleum as an insecticide. In the *Farmer's Bulletin* No. 127 on *Important Insecticides*, Mr. C. L. Marlatt says: 'Crude petroleum is used in exactly the same way as is the common illuminating oil. Its advantage over kerosene is that, as it contains a very large proportion of the heavy oils and paraffin, it does not penetrate the bark so readily, and on the other hand, only the lighter oils evaporate, leaving a coating of the heavy oils on the bark, which remains in evidence for months. Crude petroleum comes in a great many different forms, depending upon the locality, the grade successfully experimented with in the work of this Division showing 43° Beaumé. The experience of Professor J. B. Smith indicates that crude oil showing a lower Beaumé than 43° is unsafe, and more than 45° is unnecessarily high. The lower specific gravity indicated (43°) is substantially that of the refined product, the removal of the lighter oils in refining practically offsetting the removal of the paraffin.'

Professor J. B. Smith in his Report for 1901 says: 'For the conditions as they exist in New Jersey I consider the crude petroleum much the best material for use against the pernicious scale. If used undiluted, a high grade oil and intelligent care are necessary in making the application. If used in a mechanical mixture a lower grade oil may be used and 20 per cent. will be sufficient.'

The oil here referred to is a crude petroleum of about 43° Beaumé, and is applied as a winter wash against scale insects. There is no opportunity of applying such washes here as only 'summer washes' can be used; but evidently crude oil has a similar insecticidal value to pure kerosene and could replace it.

Another oil is used in California for a similar purpose. It is termed distillate, and Mr. C. L. Marlatt (*loc. cit.*) says: 'The distillate emulsion is substantially an emulsion of crude petroleum made in the same way as the kerosene emulsion, except that a greater amount of soap and only half as much oil proportionately is used. It is termed "distillate spray" because the oil used is a crude distillate of the heavy California petroleum. The product used for preparing the emulsion should have a gravity of about 28° Beaumé, and is the crude oil minus the lighter oil or what distils over at a temperature between 250°

and 350°C. In general characteristics it is similar to lubricating oil. The emulsion is prepared as follows: Five gallons of 28° gravity distillate; 5 gallons of water, boiling; 1 to 1½lb. of whale oil soap. The soap is dissolved in hot water, the distillate added, and the whole thoroughly emulsified by means of a power pump, until a rather heavy, yellowish, creamy emulsion is produced.

There are thus two grades of crude petroleum in use in the United States to replace the refined kerosene formerly used, and it seemed worth while to test such an oil under the conditions obtaining in the West Indies with a view to recommending a more efficacious and less costly mixture than the refined kerosene emulsion. Inquiries at New York showed that crude petroleum of 43° Beaumé could be obtained in the usual cases containing two 5-gallon tins at 15 cents per gallon. As this would not present any particular saving in cost after the oil were landed in Barbados, freight and duty paid, it was decided to test the crude oil which is mined in Barbados. Two samples were received from the West India Petroleum Company, labelled 'Crude Petroleum' and 'Crude Liquid Asphalte.' The former was a thick liquid of a dark, greenish black by reflected and brown by transmitted light, the latter a very viscous black liquid. Eventually the latter was abandoned in favour of the former, and the 'Crude Petroleum' alone proved to have the desired properties.

A sample of this crude oil was examined at the Government Laboratory, Bridgetown, Barbados, and the following account given of it by Mr. R. R. Hall, B.A., Acting Island Professor of Chemistry: 'I have examined the sample of oil and can give you the following information:—

Barbados oil.	Density	·9444.	Corresponding to Beaumé	18·5°
Crude Petroleum	„	·8150.	„ „ „	43°
Distillate.	„	·8990.	„ „ „	28°

with a flashing point some way above 200°F.; it thus does not correspond very closely either to the American 'Crude Petroleum' or to 'Distillate Oil.'

'This crude oil apparently contains a large proportion of the heavy "fractions" found in American oils and would probably be somewhat troublesome to refine, but probably such portions as would be blown over with steam would prove more suitable for the formation of the whale oil compound which Mr. Maxwell-Lefroy showed and described to me.

'It is apparently a solution of the heavier hydrocarbons in the lighter ones and contains very little solid admixture; filtration does very little to improve it.'

This shows the oil to be very different in character from either of the oils used in America, and accordingly tests were undertaken of its value against insects and its effect on foliage. Applied with a Gould's Knapsack Kero-water, the oil refused to emulsify satisfactorily and the damage to plants was so great that this method was abandoned. This contrasts strongly with refined kerosene which can be used at a rate of 5 to 15

per cent. in a mechanical emulsion made in this machine on almost all plants on a sunny day.

An attempt was then made to use it in mechanical emulsion with whale oil soap solution. In the Kero-water this failed, but in a small hand sprayer, where air is blown over the openings of two tubes communicating with oil and water reservoirs, better results were obtained, though only a very minute percentage of oil was blown out and mixed with the air and water. Attempts were then made to make an emulsion in water by first making a compound of soap, naphthalene and oil, and then stirring this in water. This yielded entirely successful results, and the mixture so formed has proved to be a satisfactory method of using this oil.

There remained only the ordinary emulsion with soft or hard soap, and the oil was found to yield an emulsion somewhat in the way recommended above by Mr. C. L. Marlatt for 'distillate' emulsion; but on mixing this with water, part or all of the oil separated at once on the surface. No stable wash could be obtained by adding the oil to any proportion of soap and water.

The compound formed by combining soap and oil by means of naphthalene originated with Mr. H. H. Cousins, Jamaica, (formerly of the South Eastern College, Wye.) My attention was drawn to it by Mr. F. V. Theobald when on a visit to the College at Wye, in June 1902. In the *Chemistry of the Garden*, Mr. Cousins says: 'The idea occurred to the writer that a substance which was soluble in both soap and paraffin might greatly assist in the production of a paraffin emulsion of a kind and perfection superior to that obtainable with paraffin and soap alone. As the result of exhaustive experiments, naphthalene proved to have the desired properties, and it was found that a saturated solution of naphthalene in paraffin oil combined with boiling soft soap with great ease. A semi-solid product can thus be easily prepared, which readily dissolves in water, and at a strength of 1 to 1½ parts in 100 parts of water has proved a most effectual and sound remedy for sucking insects. If properly made this compound will keep indefinitely, and when dissolved in water gives an emulsion of such fineness that no visible separation of oil takes place even after standing for weeks in the open air.'

Mr. Cousins has kindly sent additional information with details of preparing this compound. The proportions used are 10 lb. of soft soap, 3 pints of water, 1 lb. of naphthalene and ½ gallon of oil. The proportion of oil should not exceed 20 per cent.

At the beginning of my experiments I had no details of the proportions used and tried to obtain an emulsifying compound of whale oil soap, naphthalene and crude oil. Proportions of oil were used varying from 10 to 75 per cent., as it was desirable to reduce as far as possible the proportion of soap, which is the more costly ingredient. With the grade of crude oil described above, and Good's No 3. potash whale oil soap, a practically solid body was eventually obtained, containing about 35 per cent. of oil, which on agitating in water gave an emulsion

absolutely free of separating oil. With higher percentages of oil, the extra oil either separated from the solid compound immediately on cooling, or when it was mixed with water. The proportions finally found to be successful were:—

10 lb. whale oil soap.
5½ pints of oil (crude Barbados oil).
4 oz. of naphthalene.

It will be seen that these are very different from Mr. Cousins' formula, but this is probably to be accounted for by the different soap and oil used. A smaller proportion of naphthalene can be used, but this gives the best compound, and no advantage appears to be gained by increasing the proportion. In making this substance, the soap is heated in a metal vessel, and if it contains much water, it is boiled till the proportion of water is reduced. The naphthalene is dissolved in the oil by stirring and the two thrown into the soap and well stirred. On cooling a practically solid body is produced, which keeps unaltered for several months and at present shows no signs of changing in any way. The emulsion is made by simply rubbing this compound up by hand in water, or by agitating it in water mechanically. As the mixture contains roughly one-third its weight of oil, any percentage of oil can be readily obtained on mixing with water. In practice it is very convenient that the compound is solid, as it can be more easily handled and transported. A small quantity suffices to make a large quantity of wash without further heating or any labour beyond the mixing in water.

During the progress of the experiments some interesting results were obtained as to the behaviour of the soap and oil when mixed with and without naphthalene. When two parts of soap and one part of oil were heated and mixed no result was obtained, but on adding naphthalene and reheating, the emul-i-fying compound was at once obtained. When larger proportions of oil than 10 per cent. were used and the finished mixture was at once poured off into tins to cool and set, the solid compound separated out on the top, the extra oil being found at the bottom of the tin. In other cases, where too large a proportion of oil was used and the mixture was kept stirred till it cooled, the free oil could be separated by filtering through cloth, the 'compound' remaining on the cloth.

The word 'compound' is used here not as denoting that a chemical 'compound' was formed, but that a distinct material was produced in these experiments, from which superfluous oil would separate. Mr. R. R. Hall, B.A., Acting Island Professor of Chemistry, and Mr. R. D. Anstead, B.A., both gave assistance at these experiments and Mr. Anstead finally examined some of the finished product. He reported as follows:—

'The semi-solid mixture of whale oil soap and oil is certainly not a chemical compound. Under the microscope it is seen to consist of soap containing minute drops of oil scattered uniformly throughout the mass; both from this material and from its emulsion in water, ordinary solvents, such as ether, remove the oil with readiness, leaving the soap behind. In other ways also it behaves as a mechanical mixture.'

'Certain liquids have the power of forming emulsions containing a definite proportion of each. If an excess of either be added that excess simply separates out on standing. Emulsions are, as a rule, more readily formed in the presence of small quantities of certain other bodies.

'It is of great advantage in the case of a water-oil emulsion to obtain the oil first in a finely divided condition.

'Keeping this in mind, the following is a very *probable* explanation of Mr. Maxwell-Lefroy's process:

'In the first part, soap and oil boiled together form an intimate mixture, or emulsion, of definite proportions which on cooling, sets to a semi-solid condition.

'Naphthalene plays the part of the third substance mentioned above, and it is known that, for an, at present, unexplained reason, naphthalene increases the lathering properties of soap. If too much oil is present it separates out on cooling or standing.

'In the second part, this soap-oil emulsion is rubbed up with water, which dissolves out the soap, leaving throughout the solution the oil in minute globules, in which state it readily forms an emulsion, in the usual way, with the soap solution.

'This seems to explain the formation of the semi-solid material shown to me and the fact that if, properly made, it will give a good and permanent emulsion with water. This explanation also suggests to me that the important points in the manufacture of the emulsive material to be noted are:—

(1) To settle on the maximum amount of oil that will remain in emulsion as a semi-solid and never to exceed that.

(2) To add the hot mineral oil slowly to the melted whale oil soap with constant stirring and then to keep well stirred some time while hot to break the oil up into minute globules.

(3) The naphthalene which appears to behave as a catalytic agent should probably not be used in large quantities, but should be finely powdered and stirred well into the molten whale oil soap before adding the mineral oil.'

This fully explains the above facts and gives the reason why larger amounts of oil will not go into the emulsion.

The composition of the emulsion of soap and oil, with naphthalene, being constant, the proportions cannot be varied, using these particular grades of soap and oil. The emulsion also being semi-solid, separates from the excess of oil.

Light is now thrown on the subject of oil emulsions generally, and it would be of value to know if this principle applies to all grades of soap and petroleum. It might be possible to obtain an emulsion of soft soap and a lighter oil, which would contain less soap. In the experiments carried on here, it was found that a larger proportion of pure kerosene could go into the semi-solid emulsion than of crude oil, and it always appears to be the heavier constituents of the crude oil that separate from the emulsion.

Kerosene emulsions as generally used differ, in that, the oil and soap are not formed into an emulsion before they are

emulsed in water. The emulsion formed according to the Hubbard-Riley formula is really a mechanical emulsion of oil in a hot soap solution. If the kerosene and soap had previously been heated together with naphthalene, and then emulsed in water, a similar emulsion would have been formed to that obtained from the semi-solid crude oil and soap compound. No advantage attaches to this method possibly, except that the solid emulsion is very convenient to handle, and the oil, being twice emulsed, is in very fine particles. Also the crude oil obtained in Barbados cannot be used in any other way. The emulsion obtained from the crude oil and soap compound is a most valuable insecticide, from the very much increased insecticidal properties of the heavy oil used. It can be used safely, as the oil is so well broken up in the emulsion, and the oil tends to remain longer on the plant owing to its less volatile nature.

APPLICATION.

This emulsion has been tested at the rate of 1 lb. to 10 gallons of water and is then effective against *Aphidae* (plant lice), *Aleurodidae* (mealy wings), and most forms of *Coccidae* (scale insects and mealy bugs). The *Diaspinae* and some *Lecanii* (*L. nigrum*, *oleae* and *hemisphaericum*) require three thorough treatments as they are not easily killed, though the young do not survive the first treatment.

The emulsion has also been largely used on young Indian corn against the corn worm (*Spodoptera* (Laphygma) *frugiperda*), and the corn fly (*Delphax saccharivora*). These pests attack young Indian corn and frequently destroy many acres before the plants become fully established. It was found that the ordinary strength was fatal to the fly, but that for the corn worm a strength of 3 lb. to 10 gallons of water was necessary. This is also true of other caterpillars, and in cases where a contact poison is useful against caterpillar pests, this strength is suitable.

At the usual strength, the wash is entirely harmless to even very delicate plants. At three times this strength, plants suffer only when, as in the case of corn, the liquid collects in the 'heart' of the plant and remains there in some quantity. The water evaporates, leaving the oil round the base of the young leaves and the plant then dies.

This emulsion has another use against ticks and other vermin on domestic animals. It is used simply as a soap, either rubbed on the animal and then lathered, or dissolved in water and syringed or washed on. The crude oil has an immediate effect on the parasites and does not injure the skin. It forms a very useful means of applying crude oil in this way.

Probably this insecticide may be found to be the most useful yet devised for the West Indies. An insecticide must not only be effective, but it must be cheap, portable, easily procu ed and simple in use. From the point of view of cost t compares well with other insecticides, costing, per 100 gallons, from 40 cents at wholesale to 70 cents at local prices

of materials, etc. The crude oil is readily obtained in Barbados, naphthalene and whale oil (or other soft) soap can be obtained in Barbados or imported. The portability and general handiness of this compound is evident, as an ordinary 5 lb. butter tin holds sufficient for 50 gallons of wash. It needs no heating of water, or other manipulation beyond rubbing up in water, and will keep indefinitely in the solid state.

It is hoped that the problem of spraying for scale insects and similar pests will be much facilitated by the use of this spraying compound. It may now be procured in Barbados, made according to the above formula, and those who propose to use it in any quantity, will find it a simple matter to procure the ingredients and prepare it for their own use.

GREEN SORGHUM POISONING.

Wherever Sorghum has been grown for fodder an idea has been prevalent among agriculturists that the plant is, under certain circumstances, injurious to stock. Thus in India, New South Wales, the United States, as well as in the West Indies, references may be found in periodicals and elsewhere to the injurious and sometimes even fatal character of this fodder, especially when in the young state. The causes adduced to account for these results have up to the present been somewhat vague and conflicting. Some attention was devoted to the question in a publication of the U. S. Department of Agriculture, published in 1899, *Sorghum as a Forage Crop*, Farmer's Bulletin, No. 50, pp. 17 & 18.

The injurious effect of second growth Sorghum on stock seems to have arisen from carelessness in turning hungry animals into the fields and allowing them to over-gorge themselves, a result which almost always follows in feeding any succulent forage, whether of first or second crop, to half-starved animals. In the cases investigated in India and the United States where death occurred to animals fed on young Sorghum, it was found that they had eaten to excess, and that, as is usual under these circumstances, a vast quantity of gas had developed in the rumen (paunch) causing death.

There are a few cases on record when death has resulted in a very short time after but little of the plant was swallowed by the animals, and it has been supposed that under certain conditions, some poisonous substance developed in the plant was the cause of these sudden deaths. In India, under certain conditions of extreme drought, nitrate of potash appears to be formed in the closely related Johnson grass (*Sorghum halepense*) in sufficient quantity to cause the death of animals eating much of it. This seems more likely to take place when the drought is followed by a short period of excessive rainfall. Several instances have been recorded in Kansas where, under similar conditions, Indian corn has developed this same substance and cattle to which it was fed died, in some cases

quite suddenly. It is quite possible that this nitrate of potash may be developed in Sorghum and may be the cause of the trouble referred to. It is noticeable that the instances reported both in India and Kansas, followed seasons of protracted drought and took place in localities where the soil was supposed to be rich in nitrogen and potash.

The question has recently been carefully investigated in the Technical Department of the Imperial Institute, London, by Professor W. R. Dunstan, F.R.S., and Dr. T. A. Henry. A full account of their work has been published by the Royal Society, in the form of a joint paper, entitled 'Cyanogenesis in Plants. Part II. The Great Millet (*Sorghum vulgare*).' *Philosophical Transactions*, Series A, Vol. 199, pp. 399 to 410.

We are indebted to Professor Dunstan for kind permission to publish extracts from this important paper in these pages for the information of West Indian readers :—

'In a previous paper, our first communication on this subject, (*Phil. Trans.* B. Vol. 194, 1901, p. 515), we have shown that the poisonous effects produced by the young plants of *Lotus arabicus* are due to prussic acid, which is not present in the plant as such, but originates in the hydrolytic action of an enzyme, lotasse, on a glucoside lotusin. Recently we have examined a large number of plants which, like this Egyptian vetch, appear, under certain conditions, to possess poisonous properties, and at other times to be innocuous and often valuable as fodder plants or food stuffs, with the view of ascertaining to what extent they contain glucosides furnishing prussic acid.

'Among the first of these plants we examined was the Great Millet, *Sorghum vulgare*, a plant widely cultivated in tropical countries for the sake of its nutritious grain, which in many districts of India is the staple food, known as 'Juar,' of the natives. In the West Indies what is apparently the same plant yields the important "Guinea corn" and in South Africa "Kaffir corn."

'We were informed by Mr. E. A. Floyer of Cairo, that in Egypt it is well known to the Arabs that the green portions of the young plant, the vernacular name of which is "Dhurra Shirshabi" are poisonous, and that during this period the plantations are protected in various ways in order to prevent cattle from feeding on the immature growth. It is to be noted that in Egypt the name "dhurra" is also applied to a variety of maize which is largely cultivated.

'Mr. Floyer has given us the following account of the plant in Egypt. "Dhurra shirshabi" is not grown in Egypt as a crop, the yield of corn being too small. It is planted chiefly in order to shade the *Arachis* (ground-nut), to which it also affords protection in forming a poisonous hedge. The "thinnings" of the young millet are often strewn around a cultivated crop, and the neighbours are warned to keep their cattle off. The poison is most intense when young plants, 1 foot high or less, are kept without water for a long time, and such unwatered young plants are highly toxic to cows. The plant appears to have been

brought to Egypt from Syria, and is now grown chiefly at Bir Abu Bala, near Ismailia. The "fellaheen" do not plant it.

'Cases of poisoning by young Sorghum have been also recorded in America and in Australia, where the plant is grown for forage purposes.

'In India the poisonous properties of the plant which bears the vernacular name "juar" or "jowar" do not appear to be so generally known, although several well authenticated cases of the poisoning of cattle by it. especially during drought have been recorded, and much has been written on the subject by veterinary surgeons and others, who have, as a rule, assumed that the toxicity is due to the presence of a poisonous fungus or insect upon the plant, or that the Great millet is not naturally poisonous, and that the deaths of cattle as the result of eating it are due to immoderate consumption, which causes a kind of suffocation from indigestion, technically known as "hoven." The symptoms of "hoven" are not unlike those of prussic acid poisoning, and it is possible that the various leguminous fodders which are known to be particularly liable to produce these effects may, at any rate in some cases, prove, like *Lotus arabicus*, and, as will be shown in the present paper *Sorghum vulgare*, to furnish prussic acid.

'For the material we have employed in the course of this investigation we are indebted to Mr. E. A. Floyer, who was good enough to undertake its collection in Egypt at different stages of growth.

'Considerable confusion exists as to the identity of the "Great millets" grown in different tropical countries. Thus in India the plant is cultivated both as a spring and an autumn crop. The varieties ripening in the spring are probably originally derived from *Sorghum halapense*, a species indigenous to India, whilst the autumn crops are generally referred to *Sorghum vulgare*, yet both spring and autumn crops are called "juar" or "jowar." and are used by the natives indiscriminately. Again, in India a plant with an inflorescence more branched than that of *Sorghum vulgare* has been regarded as a distinct species, and named *Sorghum saccharatum*; this name is however given in the *Index Kewensis* as a synonym for *Sorghum vulgare* of which the plant is probably merely a variety.*

'The plant we have examined has been identified for us by Dr. Schweinfurth as undoubtedly true *S. vulgare*.

PRELIMINARY EXPERIMENTS.

'It was observed that the young plant when crushed and moistened with cold water soon acquired a strong odour of hydrocyanic acid. The production of this acid was confirmed by pressing out a little of the liquid from the moist plant, and distilling it, when a liquid was obtained which gave the characteristic reactions of hydrogen cyanide.

* We hope to publish shortly a revision of the nomenclature of the *Sorghums*. [Ed. W.I.B.]

'A few grammes of the plant were next exhausted by hot methylated alcohol in a Soxhlet extractor. The solvent was distilled from the solution and the residue boiled with water until nothing more dissolved. The aqueous liquid was then distilled at first alone, and afterwards with the addition of dilute hydrocloric acid ; in the former case none, but in the second, where hydrolysis had occurred, considerable quantities of hydrocyanic acid were found in the distillate.

'These observations led us to conclude that *Sorghum vulgare* contains a glucoside which under the influence of some hydrolytic agent simultaneously present, undergoes hydrolysis, furnishing as one product hydrocyanic acid, to which the observed toxicity of the young plants must be ascribed.

'A determination of the amount of acid which the air-dried plant is capable of producing at different stages of growth was made by leaving a weighed quantity in contact with water for 12 hours, and distilling off the acid formed in a slow current of steam, the liquid being titrated by Liebig's method.

'The following results were obtained :—

(*a*.) From bright green plants about 12 inches in height 20 grammes gave a distillate requiring 7·45 cubic centims. $\frac{N}{10}$ silver nitrate, equivalent to ·201 per cent. HCN.
20 grammes gave a distillate requiring 7·8 cubic centims. $\frac{N}{10}$ silver nitrate, equivalent to ·216 per cent. HCN.

(*b*.) From plants about 3 feet high, yellowish-green and ripe ; 20 grammes of these mature plants gave no indication of prussic acid, and larger quantities on distillation with water gave amounts too small to be satisfactorily estimated. No prussic acid was obtained from the seeds of the millet.

'It has been asserted by Greshoff and Treub that in many tropical plants hydrocyanic acid occurs as such, that is, in the free state. The existence of the free acid was demonstrated by these observers by immersing a thin section of the plant first in alkali, then in a mixture of ferrous and ferric chlorides, and finally in strong hydrochloric acid. If the plant tissue was stained blue, it was concluded that prussic acid in the free state was present. This test, however, appears to us to be quite inconclusive, as the mere moistening of plant tissue containing both a glucoside capable of furnishing prussic acid on hydrolysis and a hydrolytic enzyme, leads to the immediate production of free acid, which by Greshoff and Treub's method would be regarded as occurring pre-formed in the plant. We have carefully examined various specimens of dhurra for free prussic acid by the following methods.

'About 20 grammes of the finely powdered plant were placed in a distilling flask attached by its branch tube to a long condenser. Into the closed flask a rapid current of steam was passed, which served the double purpose of immediately destroying any enzyme, and of carrying through the condenser any volatile product present in the plant. In the distillate of

the plant thus obtained we never found prussic acid, either with young *Sorghum vulgare* or *Lotus arabicus*.

'It therefore appears that, like *Lotus arabicus*, the poisonous effects of the young dhurra are due to the presence of a glucoside, which yields prussic acid under the influence of an enzyme also present in the plant.

EXTRACTION OF THE GLUCOSIDE (DHURRIN).

'The finely-powdered plant was extracted with alcohol, the solvent distilled off and the residue warmed with water until nothing more dissolved.

'To this liquid aqueous lead acetate was added so long as a precipitate formed. The precipitate (lead tannate, etc.) was removed. The filtrate, which was now bright yellow, was treated with sulphuretted hydrogen, care being taken to avoid a large excess, and the lead sulphide was removed by filtration. A stream of air was then drawn through the liquid to remove hydrogen sulphide, and the solution evaporated in a vacuum. After several weeks the syrup deposited a small quantity of a crystalline substance, and more was obtained by adding small quantities of alcohol and dissolving the mixture of precipitated sugar and glucoside in a little water, and setting aside to crystallize as before. This process was very tedious, and the two following methods have been since found to yield the glucoside much more rapidly.

'1. The liquid, after the hydrogen sulphide treatment, is evaporated in a vacuum to a convenient volume, and the amount of free sugar determined with Fehling's solution. A little more than the calculated quantity of phenylhydrazine necessary to convert this amount of sugar into the osazone is then added, and the mixture heated for 30 minutes at 100 C., filtered and the filtrate shaken with ether to remove any excess of phenylhydrazine. On evaporation in a vacuum the residue generally solidified to a mass of crystals, which were easily purified by recrystallization from alcohol. The method always involves the loss of some of the glucoside, and cannot be employed in the isolation of small quantities.

'2. The second method, which is the more effective, consists in evaporating in a vacuum the extract left after the lead acetate and hydrogen sulphide treatment with sufficient purified animal charcoal to convert the whole into a powder, which is then exposed in a vacuous desicator until quite dry when it is extracted in a Soxhlet apparatus with dry acetic ether. This solvent slowly removes the glucoside, leaving behind nearly all dextrose and brown extractive matter. On distilling off the solvent a syrupy residue is left, which if necessary is again treated in the same manner; usually, however, it crystallizes after standing in a vacuum over sulphuric acid for a few days. The substance may be recrystallized from hot alcohol or boiling water.

'The glucoside crystallizes from water in brilliant leaflets and from alcohol in small, transparent, rectangular prisms. It has no definite melting point, becoming brown when heated

much beyond 100°, decomposing completely at 200°. It is easily soluble in hot alcohol, hot acetic ether and boiling water, separating in crystals on cooling. It is however retained in solution by aqueous solutions of dextrose, a peculiarity which accounts for the great difficulty we at first experienced in isolating it from the plant.

'It appears to contain water of crystallization, since it loses weight when heated for some time in a water oven, but the amount cannot be accurately determined owing to the decomposition which occurs when the substance is heated near 100°.

'Some trouble was met with in obtaining the material in a satisfactory state for analysis owing to the difficulty of removing the water of crystallization without causing decomposition.

'The following combustions were made :—

'1. Material recrystallized from alcohol and dried until of constant weight in a vacuous desiccator over sulphuric acid

·0961 gramme gave	·1887 gramme	CO_2	C	53·6	per cent.
	·0572 ,,	H_2O	H	6·5	,,
·1385 ,, ,,	·2698 ,,	CO_2	C	53·1	,,
	·0885 ,,	H_2O	H	7·07	,,

'2. Material recrystallized from water and dried at the ordinary atmospheric temperature on filter paper.

·1260 gramme gave	·2323 gramme	CO_2	C	50·29	per cent.
	·0730 ,,	H_2O	H	6·42	,,

'3. Material recrystallized from alcohol and dried in a current of warm air at 80° to 90°C.

·1021 gramme gave	·2051 gramme	CO_2	C	54·7	per cent.
	·0452 ,,	H_2O	H	4·9	,,

$C_{14}H_{16}O_7N.\ C_2H_5OH$	requires	C	53·7	H	6·44	per cent.
$C_{14}H_{17}O_7N.\ H_2O$	,,	C	51·1	H	5·8	,,
$C_{14}H_{17}O_7N$	,,	C	54·0	H	5·5	,,
$C_{20}H_{27}O_{12}N$	,,	C	50·74	H	5·7	,,

'The glucoside therefore has the composition represented by the formula $C_{14}H_{17}O_7N$, but when crystallized from alcohol or water the crystals which separate contain one molecular proportion of these solvents.

'For the glucoside thus isolated from Egyptian dhurra we propose the name *dhurrin*.

'*Hydrolysis of dhurrin by acids. Formation of prussic acid, etc.*

'When an aqueous solution of dhurrin is warmed on the waterbath with dilute hydrochloric acid, hydrocyanic acid is almost immediately evolved. If the heating is continued for some time, the liquid becomes considerably discoloured owing to the further action of the acid upon the products of hydrolysis. In addition to prussic acid, a sugar and a substance soluble in ether are produced. . . . .

THE ENZYME OF SORGHUM VULGARE.

'In the introduction to this paper attention has been drawn to the fact that the plant when moistened with cold water evolves hydrocyanic acid, whilst it no longer does so after exposure to a temperature of 100°, nor is the acid formed when the plant is placed in boiling water. These results point to the presence in the plant of an enzyme, destroyed by heat, which has the power of hydrolysing dhurrin. This enzyme was isolated by extracting the finely-ground plant with cold water, and evaporating the extract so obtained in a vacuous desiccator over quicklime to remove as much hydrocyanic acid as possible. The activity of this extract was then tested by the addition of small quantities to solutions of amygdalin, salicin and dhurrin, these experiments being controlled by the addition of boiled and filtered dhurra extract to similar solutions of these glucosides.

'In all three cases the glucoside was quickly hydrolysed, the formation of benzaldehyde, saligenin, and parahydroxybenzaldehyde respectively being recognized by the usual tests for these substances. Comparative experiments in which the action of an extract of sweet almonds was tried side by side with the dhurra enzyme on the same glucosides, showed that the two extracts behaved in precisely the same way. Similar preparations made by precipitating aqueous extracts of sweet almonds and dhurra with alcohol, and by precipitating calcium phosphate in such extracts, showed no difference of activity in effecting the hydrolysis of salicin. The glucosidolytic enzyme of *Sorghum vulgare* therefore performs the same functions as the enzyme emulsion which occurs in sweet-almonds, and in the present state of our knowledge of the chemistry of enzymes, the two substances may provisionally be regarded as identical.

THE CYANOGENETIC CONSTITUENTS OF PLANTS.

'Beside lotusin and dhurrin, the glucosides we have isolated from young plants of *Lotus arabicus* and *Sorghum vulgare* respectively, only one other cyogenetic glucoside is definitely known, that is, the amygdalin derived from bitter almonds, which however, is found in the seeds of the plant.

'The results of our investigations have rendered it probable, that the production of prussic acid in a number of other plants may be associated with the presence of cyanogenetic glucosides. Moreover the question of the occurrence of prussic acid, and the part played by it in vegetable metabolism, involves problems of the first importance in vegetable physiology, with which we intend to deal when we have obtained a further insight into the nature of other cyanogenetic glucosides now under investigation. So far as *Lotus arabicus* and *Sorghum vulgare* are concerned, it would appear that the existence of a cyanogenetic glucoside in the young plant up to the period when the seeds ripen at any rate may serve as an important protection to the plant from the attacks of animals. It appears that animals indigenous to the countries in which these plants are native, refuse to eat them in the earlier and poisonous stages of growth. The part played by the glucoside in the general metabolism of

these plants and the origin and fate of the cyanogenetic group still remain to be ascertained. The temporary presence in a plant of a considerable quantity of a cyanogenetic glucoside, together with an enzyme capable of decomposing it, appears to us to be a fact which must have an important biological meaning.

'As so much interest attaches to the subject from several points of view, we are engaged in investigating the constituents of other plants which furnish prussic acid. Among them we may mention *Phaseolus lunatus* (seeds), *Lotus australis*, *Manihot utilissima* and *Linum usitatissimum*, as well as a number of little known plants, derived from the colonies, which have proved to be poisonous to cattle, some of which may contain cyanogenetic glucosides. From the chemical point of view it is important, in the first instance, to isolate these glucosides and to ascertain their properties, composition, and molecular structure. This work we have now accomplished with the glucosides of *Lotus arabicus* and *Sorghum vulgare*, which are shown to be radically different in chemical constitution, whilst each belongs to a type chemically distinct from that of amygdalin the only naturally occurring cyanogenetic glucoside hitherto definitely known.'

BIRDS OF BARBADOS.

The following interesting paper on the Birds of Barbados was contributed by Colonel H. W. Feilden to *The Ibis* in 1889. As practically nothing further has been written on the subject and the original paper is known to few in the West Indies, it has been decided, with the permission of the author, to re-print it in the pages of the *West Indian Bulletin.*

The following is an extract from a letter from Colonel Feilden, dated West House, Wells, Norfolk, October 6, 1902 :-

MY DEAR DR. MORRIS,

I was much pleased to receive yours of September 13 and the Bulletins, Pamphlets and *Agricultural News* which I have read with great interest.

In reference to my paper on the 'Birds of Barbados,' *Ibis*, 1889, it is the result of less than twelve months' observation in the island : necessarily it must have many imperfections, and no doubt a resident would add very largely to the list of casual visitants.

Your introduction of a new species the *Pied carreau* is of interest and should be recorded.

I do not recognise the species referred to under the name of 'Grass canary,' but if you will send me a specimen I will get it identified.

Situated as I am in England, it would be out of my power to revise the 1889 list, for its sole merit lies in the personal

observations recorded. If you consider it worthy of re-print, I would suggest that it be re-published in its entirety; it may act as a stimulus to some resident to continue the observations on the Barbados *avi-fauna* and add to and correct mine.

BIRDS OF BARBADOS.

BY COLONEL H. W. FEILDEN, F.G.S., C.M.Z.S.

[Re-printed from *The Ibis*, 1889, pp. 477 to 503]

The most noticeable feature in connexion with the ornithology of the island of Barbados is the paucity of resident species of birds: but there are several reasons which well account for this deficiency, and these may be considered under the headings of its geological structure, its geographical position, and the paucity of swamps and marshes, the almost total destruction of the natural forest-growth, which covered the island when first settled by Europeans in the beginning of the seventeenth century, and the wonderfully high state of cultivation which is the marked feature of the island at the present time.

Barbados is separated from the other islands of the Lesser Antilles by a great oceanic depression; soundings of from 1,000 to 1,500 fathoms being shown on the Admiralty charts between it and the islands of St. Vincent and St. Lucia, the nearest of the Lesser Antilles, which lie about one hundred miles to the westward. Between Barbados and the island of Tobago, to the southward, which latter has in all probability been connected with the mainland of South America since the introduction of its existing fauna and flora, we find a depth of over 1,000 fathoms; to the eastward of Barbados the floor of the ocean rapidly sinks into the profound depths of the Atlantic. Though Barbados is not separated from the chain of the Lesser Antilles or the mainland of South America by any great expanse of ocean, yet I think the most cursory examination of its geological structure will satisfy the observer that it can lay claim to being a truly oceanic island, in the sense of its never having formed part of a continent since the introduction of its present, comparatively speaking, meagre fauna. A singular feature in the geological structure of Barbados is that, although it attains to a height of over 1100 feet, no true volcanic rocks, so far as I am aware, protrude themselves through the exposed strata of the island, which are sedimentary stratified rocks. I do not, of course, include in the sedimentary rocks the coral capping which covers more than six-sevenths of the superficial area of Barbados, or about ninety-one thousand acres, whilst the area from which the coral has been denuded by subaerial causes, and where the basement rocks are exposed, occupies only about sixteen thousand acres. This denuded area is known by the name of the 'Scotland District,' owing to its hilly and peaked character, and offers a most striking contrast to the gentle slopes and terraces of the coral-covered area, which is the part of the island generally seen by the casual visitor to its shores.

The strata which form the basement series of Barbados are extremely contorted and have been greatly disturbed; they consist of a variety of rocks, siliceous sandstones, calcareous sandstones, clays containing selenite, clays impregnated with mineral oil, and at some points veins of bituminous coal. Their precise age has not been accurately determined, but they are probably late Eocene or Miocene, and point to correlation with those of Trinidad, and consequently at one period of time to a connexion with the South-American continent. It can hardly be doubted that these basement-rocks, or 'Scotland Series,' were formed either as estuarine or shallow-sea deposits, and in close contiguity to some great land-area. Resting unconformably on the 'Scotland Series' are vast deposits of oceanic ooze, built up, in some cases almost entirely, from the tests of Rhizopods. The modern coral cap of the island has been built up step by step upon these thalassic oozes as they emerged at intervals from the ocean. It would therefore appear that between the period of the deposition of the rocks that form the basement-series of the island there must have been a submergence of not less than a thousand fathoms to have brought them into harmony with the surrounding floor of the ocean, and to have admitted of the deposition of the beds of deep-sea ooze which now rest upon them. The modern coral-coated island of Barbados dates back no further in time than the period when the elevatory process brought the deep-sea deposits sufficiently near the surface to admit of the reef-builders commencing work. The deep water that surrounds Barbados is proof that it has had no continental connexion since it emerged as a coral-reef from the ocean.* I believe that the examination of the flora and fauna of Barbados will show their comparatively recent origin. So far as I can judge, the mammals, reptiles, and land-molluscs owe their introduction either to ocean currents, accidental occurrences, or to the direct agency of man, and a review of its avi-fauna does not point to a different conclusion. After careful investigation, I am unable to admit more than fifteen birds as residents, and in the case of one, *Tyrannus rostratus*, I am open to correction, though I saw it during six consecutive months. These residents are: –*Dendrœca capitalis*, *Certhiola barbadensis*, *Euethia bicolor*, *Loxigilla barbadensis*, *Quiscalus fortirostris*, *Elainea martinica*, *Tyrannus rostratus*, *Eulampis holosericeus*, *Orthorhynchus cristatus*, *Zenaida amabilis*, *Chamæpelia passerina*, *Ardea virescens*, *Gallinula galeata*, *Fulica americana*, and *Puffinus auduboni*. In addition I have notes of sixty-seven other species, a large number of which, especially amongst the family of the Charadriidæ, are regular birds of passage. Others, again, are merely accidental wanderers, such as *Machetes pugnax*, *Vanellus vulgaris*, *Ægialitis hiaticula*, and *Hydrochelidon leucoptera*, the occurrence of which in Barbados is as remarkable as that of American species in Europe.

* The most exhaustive account of the Geology of Barbados, is contained in the papers of Profs. J. B. Harrison, and A. Jukes-Browne, published in the *Quarterly Journal of the Geological Society of London*, Vol. XLVII pp. 197 to 250 and Vol. XLVIII pp. 170 to 226. They also issued an excellent, coloured geological map of the island. [Ed. W.I.B.]

My stay in Barbados was one year, during which time I was absent from the island over four months on tours of inspection throughout the West Indies. The catalogue I have drawn up, modest as it is in regard to numbers, represents a large amount of observations, which are chiefly due to my excellent friends Dr. C. J. Manning, M.D., and Mr. J. P. Massiah, Stipendiary Magistrate of Bridgetown, Barbados. I may say that whatever value these notes possess is chiefly due to the assistance afforded me by these two gentlemen. I am likewise greatly indebted to the Rev. G. Duncan Gittens, M.A., Rector of St. Lucy's parish, and to Mr. Herbert Hart, of Fairfield, St. Philip's.

1. MARGAROPS DENSIROSTRIS (Vieill.). Thrush.

I failed to find this species or any bird that might be entitled to the name of Thrush, resident in the island, though Hughes, writing in 1750, gives the impression that such might have been the case at that date. I made every inquiry in regard to 'Thrushes;' and though birds answering to their description are seen at intervals, yet I am inclined to think they are only individuals passing through at the periods of migration. Dr. C. J. Manning obtained a fine specimen of *Margarops densirostris* in his garden at Bagatelle on March 2, 1889, which he kindly forwarded to me. It proved to be a male. It is not likely that so large and striking-looking a bird could be a resident in Barbados without the fact being known.

2. PARULA AMERICANA (Linn.).

Mr. Herbert Hart, of Fairfield, St. Philip, gave me a mounted specimen of this species, which he had shot in his garden in the month of June, a very late date for this migratory bird to have remained in Barbados. Gosse gives April 20 as the latest date for its stay in Jamaica. On November, 4, 1888, I recognized one in an oleander bush within two feet of me, in a garden at Hastings, and subsequently I met with several others at various spots in the island.

3. DENDRŒCA CAPITALIS (Lawr.). Yellow-Bird.

This species is peculiar to Barbados. The bright yellow plumage of the male makes it a very conspicuous object. It is extremely common throughout the island from the higher elevations to the shore-line. It is often to be seen hopping among the stalks of the growing maize and other plants, though it is equally arboreal in its habits, and addicted to the shade of the broad-leaved sea-side grape (*Coccoloba*). Its food is chiefly insects. There was a pair of these pretty little birds that made their headquarters all the year through in a tree close to my dwelling, and I have seen one fly down and attack a large spider on the ground, which took it some time to kill. Wishing to see the species of spider, I stepped out and took it up; the little Yellow-bird only retreated a few paces, and the instant I dropped the spider, returned and snapped it up. This bird has a short and melodious song, of no great strength or compass, but in the mornings, shortly after sunrise, every grove and clump of trees resounds with

their pleasing warble. The nest is a compactly built structure of grass and roots, with a few feathers interspersed, dome-shaped, depth inside 3 inches, entrance 1¼ inch. The newly-hatched young are bright yellow-tinted.

4. DENDRŒCA STRIATA (Forst.). Swamp Sparrow.

I first met with and obtained this species among the mangrove bushes bordering Valentia Swamp on October 20, 1888. I was attracted by its sharp note; the coloured lad with me recognized it as the 'Swamp Sparrow;' it is therefore in all probability an annual visitor. I saw two or three more at the same place later on in the year, but was unable to procure another example. When alarmed they hide in the thickest bush; the note is a monotonous 'chip, chip, chip.' The specimen obtained is either in winter plumage or in that of the young bird.

5. SIURUS NÆVIUS (Bodd.).

From its small size and plain plumage this species may be more abundant than I suppose, as it ranges in winter throughout the West Indies. I only noted two examples in Barbados, one at Brandon, the residence of Mr. Edmund Taylor, on November 5, 1888, and another which I procured at Chancery Lane on the 24th. of the same month.

6. SETOPHAGA RUTICILLA (Linn.). Goldfinch.

An annual migrant, arriving in Barbados towards the middle of September, where it is known by the name of Goldfinch and Christmas-bird. I observed individuals remaining as late as February. The bright plumage of the male bird makes it a very conspicuous object as it flits about from branch to branch amid the green foliage.

7. CERTHIOLA BARBADENSIS. Baird. Sugar-bird.

The Barbados *Certhiola* is very abundant throughout the island, and when the great American aloe is in bloom may constantly be seen creeping and searching about its yellow blossoms, which appear equally attractive to the Humming-birds. It is also very partial to the moringa (*Moringa pterygosperma*) when in flower. It has a metallic note, which sounds to me as 'zic, zic, zic,' rapidly repeated; this it utters when flying as well as when perched in the trees; it flies high and settles on the topmost branches of mahogany, manchineel, and tamarind trees.

8. PROGNE DOMINICENSIS (Gmel.).

Schomburgk, in his *History of Barbados* (p. 681), includes this species as a visitor to the island under the name of 'The Large Swallow' (*Hirundo dominicensis*, Linn.).' As this bird is abundant and resident in the islands of Grenada and St. Vincent, I see no reason to doubt the correctness of Sir Richard Schomburgk's observation that it has been observed in Barbados.

9. HIRUNDO ERYTHROGASTRA (Bodd.). Swallow.

An annual and abundant visitor, arriving in the end of

August or beginning of September, and some remaining till February; they haunt the meadows near the shore. On September 10 I observed them at Chancery Lane flying by scores, both old and young. I have also many notes of having seen them in numbers in other parts of the island as late as December.

10. VIREO CALIDRIS (Linn.).

Dr. Manning gave me a specimen shot in a garden near Hastings on September 17, 1888, and I obtained another on October 15, from the same locality. Mr. W. B. Richardson likewise procured it in Barbados during the winter of 1885-86*. I do not consider this bird resident in the island, but merely an autumnal and winter visitant.

11. PYRANGA RUBRA (Linn.).

Mr. C. B. Cory has recorded this species from Barbados, a specimen from that island being in the United States National Museum.

12. LOXIGILLA BARBADENSIS, Cory. Sparrow.

Mr. Cory has separated the Barbados form of *Loxigilla* from *Loxigilla noctis* (Linn.): *vide* Auk, iii. p. 382 (1886). Resident, and one of the most common species of bird in the island, being even more tame and impudent in its conduct than an English city-bred Sparrow; it is a constant attendant at the breakfast table, entering by the open windows, perching on the backs of chairs and sideboards, and levying toll from the eatables placed on the table. It has a rather sweet but monotonous song as well as a chirp. It makes its nest, from March to June, fully exposed in the branches of trees, a large domed structure, composed of grass and roots, lined with finer material and a few feathers. The eggs are three in number, white, blotched and speckled with reddish brown. The old birds feed their young by regurgitation, putting their bills into the mouths of their nestlings.

13. EUETHIA BICOLOR (Linn.). Cane Sparrow.

Common throughout the island. It is very noticeable when the Guinea-grass is in flower, small parties are constantly flying from stem to stem, the birds clinging to them and feeding on the ripe seeds. Throughout the year it is found spread over the island, particularly on the sour-grass pastures. It has a peculiar flight, just before alighting it quivers its wings with a rapid motion, the wings vibrating like those of a Humming-bird. The nest is generally placed in low bushes, though I have found it at a considerable height in a tree. It is made of grass and fine roots, and is domed; the number of eggs three; they are white, with minute brown spots.

14. AGELÆUS ICTEROCEPHALUS (Linn.).

Dr. Manning procured a specimen of this species in the autumn of 1887, which he kindly placed in my collection. It must be a very rare and accidental visitor to the island.

* *Cf.* Cory, *The Ibis*, 1886, p. 472

15. Dolichonyx oryzivorus (Linn.).

Dr. Manning shot a female of this species in October 1887; Mr. Herbert Hart has another in his collection of Barbados birds, shot some years ago. I came across a flock of seven at Chancery Lane on October 13, 1888, out of which I shot two specimens; both proved to be males. They were quite tame, and when disturbed tried to hide themselves in some coarse sedge growing round a marshy spot. I received another example, a male shot at Græme Hall swamp on October 26, 1888. An example of this species has been procured by Mr. J. W. Wells in the island of Grenada. Mr. Cory records it from the Bahamas, Cuba, Jamaica, and Grenada. I expect that it will be found to be an annual visitor to Barbados during the autumnal migration.

16. Quiscalus fortirostris, Lawr. Blackbird.

The Barbados Blackbird is found in large numbers throughout the island. It breeds in April, May, June, and July, sometimes in colonies. A favourite site for the nest, which is a large roughly-built structure of grass and roots, is on the slender branches of the mahogany. The eggs, usually three in number, are very handsomely blotched and streaked with dark umber-brown on a greenish-lilac ground. Old and young flock together in autumn and visit the fields and savannahs in companies like our British Starling (*Sturnus vulgaris*). They do considerable damage to the planter by eating and destroying grain, but they also consume large numbers of insects, following the cattle in the fields for that purpose. The singular use these birds make of their tails has been remarked on by Ligon, writing nearly two centuries and a half ago, who thus refers to it:—'One thing I observe in these birds, which I never saw in any but them, and that is, when they flie, they put their train into severall postures; one while they keep it straight, as other birds: sometimes they turn it edge-waies, as the tail of a fish, and by and by put it three square, with the covering feather a top, and the sides downward.' In the adult bird the iris is straw-yellow, in the young white. When in full breeding-plumage both sexes are alike, black glossed with purple on the upper parts, the female less brilliant than the male; the young are likewise black. Towards autumn the plumage in many cases assumes a decided chocolate-brown colour, but this is owing to a loss of colouring in the old feathers; they moult in August, September, and October; specimens procured at that time distinctly show the new black feathers underneath the sun dried and abraded old ones.

17. Elainea martinica (Linn.). Peewhittler.

Mr. Cory has lately bestowed the specific name of *barbadensis* on the form found in Barbados; I have, however, retained the older designation. This is a common bird throughout the island wherever groves of trees are to be met with. It is the first bird that heralds the approach of day, and just before dawn its cry of 'pee-wee, pee-wee' is to be heard from tree and copse. It is a lively little creature, darting from tree to

tree and perching on the ends of the branches, erecting its crest and uttering its singular notes, but extremely timid and shy if it finds itself observed.

18. TYRANNUS ROSTRATUS, Sclater. Rainbird.

I think that I may reasonably include this bird as one of the resident species, as I have seen it in the island during every month from December to July inclusive. On June 7, 1888, we obtained a nest with four eggs incubated, which was placed on the frond of a high palm-tree in the garden of Erdiston House. The nest was a slight fabric, composed of dried grass and roots. The eggs are very handsome, creamy white, with chocolate blotches at the larger end.

19. CHORDEILES VIRGINIANUS (Sw.). Goatsucker.

Probably an annual visitor during the autumn, as a bird either of this or of some closely allied species is well known to the sportsmen of the island. I am indebted to Mr. Herbert Hart for a male specimen of *C. virginianus*, which he obtained in St. Philip's parish on September 29, 1887.

20. EULAMPIS HOLOSERICEUS (Linn.). Doctor-bird.

Is extremely common and not at all shy. I did not obtain its nest. There is very little difference in the plumage of the sexes, but I fancy the female has a somewhat longer bill than the male. The trivial name of Doctor-bird, so frequently applied to Humming-birds in the West Indian islands, takes its origin, I believe, from the apothecaries having usually been the taxidermists throughout the West Indies, so that the negroes finding a sale for these birds with them, conceived the idea that they were used for medicinal purposes.

21. ORTHORHYNCHUS CRISTATUS (Linn.). Doctor-bird.

Very abundant and excessively fearless: I have seen them humming round a blossom in the bush when within a yard of my face. It has a shrill note, frequently uttered when flitting from blossom to blossom. It very often perches on the telephone wires, seated quite upright in the position of a Kingfisher. The females strike me as having longer bills than the males. I found a nest with two young ones in it on October 30; it was fastened to the edge of a leaf of the prickly pear; the similarity of this nest to the fruit growing on the same bush was so complete that when within a few inches I could hardly believe that it was not the fruit; my attention was attracted in the first instance by seeing the female apparently crouching on the top of a fruit. In the young the beak is yellow, short, triangular, and with a wide gape, showing its affinity to *Cypselus*. Eggs two, pure white.

Obs. I have frequently heard of other species of Humming-birds being seen in Barbados, but I have only obtained or observed myself the above-mentioned two species. *Trochilus colubris* has been so accurately described to me by a resident as having been observed by him in Barbados, that I have little doubt of its having occurred there.

22. Coccygus americanus (Linn.).

A single example, a male, was shot at Græme Hall swamp on October 6, 1888. I am indebted to Mr. Herbert Hart for this specimen, which was forwarded to me in the flesh; it was very plump and in beautiful condition; its stomach contained remains of insects.

23. Ceryle alcyon (Linn.). Loggerhead Mango-bird.

An annual visitor in considerable numbers during the autumn and winter. It frequents the shore, perching in the trees that edge the beach. I have noticed as many as a dozen individuals during the course of an afternoon's walk in the month of October. At Valentia swamp, where they were common in winter, they seemed to be in pairs, and pursued their antics in the air, gamboling with one another and frequently uttering a harsh note, 'churr, churr.' I have been assured that individuals remain in Barbados throughout the year, especially in the vicinity of Consetts Bay and Joe's River; but the nest has not been discovered, neither was I able to verify the fact of this species remaining the entire twelve months in Barbados.

24. Strix flammea (Wilson).

It is with considerable diffidence that I place the name of this Owl in the list, but as Schomburgk includes it without any doubt or hesitation, I do not like to ignore his statement. This Owl is very common in Grenada and in St. Vincent, the latter island being not one hundred miles distant from Barbados; its occurrence is therefore not improbable. Personally I found no trace of any Owl in the island.

25. Pandion haliaetus (Linn.). Osprey.

An irregular and somewhat rare visitor in the fall. Several appeared during the month of October 1887. One of these is preserved in the collection of Dr. Manning; another, a female, shot about the same time, is in the possession of Mr. Herbert Hart. An adult male, shot at Græme Hall swamp on September 28, 1888, was forwarded to me in the flesh by Dr. Manning.

26. Circus hudsonicus (Linn.).

I have the skin of an immature bird from the collection of Dr. Manning; it was obtained by that gentleman in St. Philip's parish during September 1886. This species had not previously been recorded from Barbados, and, according to Cory, has hitherto only been obtained in the West Indies in Cuba and the Bahamas.

Obs. Schomburgk gives *Buteo borealis*, Swainson, a place in his list as one of the indigenous birds of Barbados. This is an error; no member of the Falconidæ is resident in that island, nor can have been for over a hundred years, otherwise Hughes would certainly have referred to the circumstance in his *Natural History of Barbados*. But a reference to Ligon's *History* (p. 60) shows clearly that in his day, when the greater part of the island was clothed in natural forest, a

species of Buzzard was indigenous. This may have been *Buteo latissimus* (Wils.), at the present time numerous and resident in St. Vincent. Ligon writes:—'The birds of this place (Barbados) (setting two aside) are hardly worth the pains of describing: yet in order, as I did the Beasts, I will set them down. The biggest is a direct Bussard, but somewhat lesse than our grey bussards in England, somewhat swifter of wing; and the only good they do is, sometimes to kill the Rats.'

27. FALCO PEREGRINUS, Tunstall.

I am indebted to Mr. E. N. Armstrong, of the Crane Hotel, for a fine female example of this species, which was shot near his residence on the windward side of the island, November 17, 1888.

Obs. Falco columbarius, Linn. is included by Schomburgk in his list as one of the indigenous birds of Barbados, but this is an error. It is, in all probability, an occasional visitor to the island, and a Hawk which one of our party saw at Chancery Lane on November 3, 1888, probably, from his description, belonged to this species. Mr. Wells has recorded it as an autumnal visitor to the island of Grenada, arriving along with the Limicolæ. On October 27, 1888, whilst driving in Christ Church parish, a small Hawk dashed past the horse's head; it was, I think, undoubtedly *Falco sparverius.*

28. ZENAIDA AMABILIS, Bp. Wood Dove.

This beautiful species is not uncommon in places where it obtains protection, being numerous in the grounds of Codrington College, where it nests on the fronds of the lofty palmistes. I have often seen it in the gardens about Bridgetown, especially in those of Government House and Bishop's Court. During my stay in Barbados I neither fired at nor handled one of these birds, and I rather regret now that I did not obtain a specimen for complete identification. This species nests in cliffs as well as in trees. The Hon. Mr. H. King informed me that he had taken the young from the most precipitous side of Chalky Mount.

29. CHAMÆPELIA PASSERINA (Linn.). Ground Dove.

Resident and very numerous, especially on the sand-dunes which border some part of the coast. I have heard of as many as fifty couples having been shot in a day by two guns. Manchineel bushes are very often selected as nesting-sites; the nest itself, composed of a few grass-stems and roots, is so frail that the two white eggs may often be seen through the structure. This bird frequently drops her eggs on the ground.

Obs. Numida melagris, Linn. Guinea-fowl. Common in a domesticated state, but does not run wild as in the island of Barbuda.

30. ORTYX VIRGINIANUS (Linn.). Quail.

Is a very rare visitor to Barbados. Dr. Manning has a

specimen shot at Bank Hall, in St. Michael's parish, during September 1886; the same gentleman saw another in St. James' parish during September 1887, but did not succeed in shooting it. This species is included by Schomburgk in his list.

31. SQUATAROLA HELVETICA (Linn.). White-tailed Plover; Loggerhead; Rock Plover.

This is rather a rare autumnal visitant, in some years none alighting; it generally arrives after the Golden Plover, towards the close of the shooting-season; it hardly ever settles on the pastures or by the decoy-ponds, but on the rocky shore, where it consorts with Ringed Plovers, Turnstones, and Sanderlings. I procured a specimen on September 22, 1888.

32. CHARADRIUS DOMINICUS, Müll. Golden Plover.

Stragglers arrive as early as July and the beginning of August, but the main flights come with the first heavy weather after August 27, and long experience and observation prove that this date is kept year after year with wonderful accuracy. The course of all the migratory Charadriidæ across Barbados in the autumn is from the north-west to south-east, and if the wind blows from south-east the birds are brought down to the island, for it appears to be a tolerably well established observation that birds prefer migrating with a 'beam' wind. A shift of wind from the north-east, with squally weather to the south-east, is ardently longed for by the Barbados sportsmen towards the end of August, as this forces the migratory hosts to alight instead of passing over at a great height, as they are seen to do when the wind is from the north-east. The first arrivals of this species are invariably black-breasted birds, showing that the old birds precede the young, and the first comers are nearly all males. The young birds without black on the breast appear about September 12, and continue to pass till the end of October, sometimes stragglers are as late as November. Even in the most favourable seasons, only a fraction of the immense flights that pass over the island ever alight; but if, attracted by the green land and 'mock-birds' pegged out near the shooter's hut, they deviate from their line of flight, they are doomed, for so well do the sportsmen imitate the call of the Golden Plover, and so irresistible is the charm, that the birds come down to it, and in spite of gaps in their ranks, they wheel round and dash past the shooter again and again till all are killed.

33. ÆGIALITIS SEMIPALMATA (Bp.). Ring-neck.

This bird arrives in August and remains till the end of November; it is one of the last of the Charadriidæ to quit the island. It does not appear in large flocks, but consorts with *Tringa minutilla*, *Tringa fuscicollis*, and *Ereunetes pusillus*. It also affects the shore-line, running about among the sea-weed cast up by the waves.

34. ÆGIALITIS HIATICULA (Linn.).

This must be a very rare visitor; I only obtained one example, which was shot at Chancery Lane, September 10, 1888. Mr. Massiah at once recognized its note as different from that of *Æ. Semipalmata*, which attracted his attention, and he succeeded in shooting it. I submitted this specimen to Mr. Seebohm, who remarks: 'It certainly is not *Charadrius Semipalmatus*. Both the length of wing and of bill are too large, and the webs between the toes are much too small. Wing from carpal joint 5·1 inches. It may be a large *Charadrius hiaticula*, which varies from 4·8 to 5·2, or it may be a small *Char. hiaticula major*, which varies from 5 to 5·5 inches. In the latter case it was bred in the British Islands and flew across the Atlantic, which is very improbable; in the former case it was most likely bred in Cumberland Sound.'

35. STREPSILAS INTERPRES (Linn.). Sandy Plover.

Arrives in August, and consorts with the Sanderlings about the sandy beaches and rocky shores. I obtained four on August 22 in full breeding-plumage, and subsequently procured many others. The first arrivals were the adults, the immature birds arriving in September.

36. RECURVIROSTRA AMERICANA (Gmel.).

Decidedly a very rare straggler to the island. Mr. Massiah informed me that he shot one at Valentia swamp in the autumn of 1880, and Mr. I. Tinling shot another on October 1, 1888, at Finney's Hill, St. Philip's parish.

37. HIMANTOPUS NIGRICOLLIS (Vieill.).

A rare visitor, though seldom a year passes without one being shot at Græme-Hall swamp. Mr. I. Tinling informed me that he saw one shot there in the autumn of 1887, and another on September 17, 1888.

38. GALLINAGO WILSONI (Temm.). The Snipe.

A regular autumnal visitor, sometimes in considerable numbers. Mr. Massiah has shot ten couple in a day at Chancery Lane; I have shot them in the same locality during the months of September, October, and November. There are very few spots in Barbados at all suitable for Snipe.

39. MACRORHAMPHUS GRISEUS (Gmel.). Duck-leg: Duck-bill.

Though a regular, is somewhat of a rare visitor, appearing along with flights of Yellow-legs (*Totanus flavipes*) in August and September. It is, however, sufficiently numerous to be given a local name by the Barbadian sportsmen. I have a specimen, a male, shot by Dr. Manning at Bagatelle on August 24, 1888, and two others shot by Mr. Massiah at Chancery Lane on the following day. I have seen several other examples shot during 1888 at the latter place.

40. MICROPALAMA HIMANTOPUS (Bp.). Cue.

Arrives with the Yellow-legs in July, and continues to pass all through August, and generally into the middle of Sep-

tember, when the flights cease, but stragglers drop in at intervals till October. This bird is easily attracted by the imitation of its call-note, and the flocks are very compact, so that at times many are brought down at one discharge of a gun. They feed on the edges of freshwater swamps, and do not alight on the dry meadows nor on the sea-beach. The flights only remain on the island for a few hours.

41. EREUNETES PUSILLUS (Linn). Grass Nit.

Arrives in flocks along with *Tringa minutilla* and *Tringa fuscicollis* in the middle of July, and remains on the island till the end of October.

42. TRINGA MINUTILLA (Vieill.). Cockroach Nit.

Arrives in flocks about the middle of July, remaining till the end of October. I have frequently seen them flying in companies of thirty or forty. They are most confiding little birds and alight almost at the feet of the gunners when called by the whistle. They are considered delicate eating, and sad havoc is at times made in their ranks by a discharge of small shot. The note may be described as resembling 'crete-crete,' frequently repeated.

43. TRINGA MACULATA (Vieill.). Chirp; October Chirp.

The Pectoral Sandpiper commences to arrive in July and August, increasing in its numbers till October, when they usually appear in immense flights; a few stragglers pass over as late as the early part of November. This bird on its arrival in the island, frequents flooded and marshy spots where the grass is short, likewise feeding on the ploughed lands. The Barbadian sportsmen, many of whom have the most discriminating ear for the notes of the various migratory birds, consider that there is a difference between the notes of the smaller and earlier arrivals, which they designate 'Chirps,' and those of the later arrivals, which are called 'October Chirps'; these are, as a rule larger and finer-looking birds, but I think it is merely that with this species the immature precede the adult birds on the southward migration. Mr. Massiah has drawn my attention to a habit of this bird, which I have not previously seen noticed; when reaching the ground, and alighting from passage, all the individuals in the flight throw themselves on the ground with their breasts touching it, in the position of a brooding hen or pigeon on eggs. Has this habit anything to do with its trivial name of Pectoral Sandpiper?

44. TRINGA FUSCICOLLIS (Vieill.). Gray Nit.

Arrives in July and continues on the island till the end of November, receiving additions to its numbers. It flies in company with *E. pusillus* and *T. minutilla*, and I have brought all three down at one shot. They are considered good eating, and numbers are shot when larger birds are not on the wing. No amount of shooting at them will deter these birds from returning to the edges of the same small swamps to feed, until all are killed.

45. TRINGA CANUTUS, Linn.

This is included by Schomburgk in his list of Barbados birds, and he also ascribes to it the local name of 'Mopus,' which, however, is not recognized at the present day by the Barbados gunners. It is evidently a very rare straggler to the island. I have a single example shot at Chancery Lane on September 6, 1888, and I did not hear of any others being procured during that season.

46. MACHETES PUGNAX Linn.

Writing in 1848, Schomburgk includes this species in his list and remarks:—'The Ruff Sand Piper is a British bird; and I have been informed that it is the first time that this species has been recorded as having been found on the other side of the Atlantic.. Mr. Bishop sent it to me among other migrating birds, and observed that its name was not known, from which I infer that its occurrence in Barbados is a singular circumstance.' I am indebted to Mr. H. Alleyne, of The Ridge, Barbados, for presenting me with a specimen of the Ruff in full breeding-plumage, which was shot at Græme Hall swamp in 1878 by Mr. H. Simpson, of Bridgetown.

47. CALIDRIS ARENARIA (Linn.). Sandy Snipe.

Arrives in August and remains in Barbados till the end of the year. I only met with it on the sandy shores of bays in small parties of four or five. Specimens I procured in August were in complete winter plumage.

48. LIMOSA HÆMASTICA (Linn.). Godwit.

An annual visitor, in some years far more numerous than in others, generally arriving in October. Mr. Massiah informed me that he has a note that on October 10, 1878, this species passed over the island in large and continuous flocks the whole day. I have an example in my collection, a male, shot at Græme Hall swamp by Mr. H. Hart on October 6, 1888.

49. VANELLUS VULGARIS, Bechst.

Dr. C. J. Manning has in his aviary a live Lapwing, which was shot at and injured in one wing on December 24, 1886, in the island of Barbados. This bird had been eighteen months in confinement when I saw it, and appeared to be quite healthy. I have already recorded this remarkable occurrence in the *Zoologist* for 1888, p. 301.

50. SYMPHEMIA SEMIPALMATA (Gmel.). White-tailed Curlew.

This is an annual, but not by any means an abundant, visitor. I obtained two examples in August, and another on September 3, 1888, at Chancery Lane.

51. TOTANUS MELANOLEUCUS, Gmel. Pika.

This bird arrives as early as May: I have a note of three having been seen at Græme Hall swamp on May 5, 1888 (*fide* C. Manning), but the main flights occur during September and October, arrivals continuing in diminished numbers till the middle of November. This is one of the most highly esteemed

for the table of the migratory Waders. It appears in comparatively small parties: a flock of twelve or fifteen arriving together is considered a large flight.

52. TOTANUS FLAVIPES, Gmel. Longlegs.

Arrives in flocks about July 15, though stragglers put in an earlier appearance. I shot an example on July 4, at Græme-Hall swamp. The passage lasts till the middle of September, only odd birds appearing after that date. The Yellowshanks is the most numerous of the migratory Waders, and generally forms the chief feature in the bag of the Barbadian sportsman. The flocks do not, however, remain long on the island, but pass on after a few hours' stay.

53. RHYACOPHILUS SOLITARIUS (Wils.). Black-back.

This species is hardly reckoned a game bird by the Barbadian sportsmen, and is not generally put up with the bunches of dead fowl, as it is supposed to spoil them. It has a strong and disagreeable odour, very noticeable when skinning a specimen. It never flies in flocks, but I have seen them collected in some numbers in wet meadows, when, if disturbed, they fly off in pairs or independently. This bird arrives in July and remains till the end of November.

54. TOTANUS MACULARIUS (Linn.). Wag: Spotted Wag.

This species is very common in Barbados, arriving in large numbers in July and August. I shot an immature bird on July 4, 1888, and I have been assured on good authority that examples may be met with in the island during every month of the year, especially about the streams in the Scotland District. It resorts on arrival to any small piece of swampy ground, and also lies out in dry yam-fields near swampy spots; it is likewise a sea-shore feeder, for I have often flushed it from the coral-reef at low water, and small parties, both in the adult and immature dress, may be seen on the sandy beaches following up the retreating waves, like Sanderlings.

55. BARTRAMIA LONGICAUDA (Bechst.). Cotton-tree Plover.

Generally arrives about the middle of August, and a few remain till March. On arrival the flocks break up and scatter over the grass-lands, cornfields, yam and sweet-potato patches, feeding on grass-hoppers, beetles, and other insects. They are not attracted by the 'mock-birds,' neither do they respond to the whistle of the sportsman. They run as fast as a Guinea-fowl, and generally rise well out of shot. Their note is peculiarly pretty, a soft liquid cry. The local name given to this bird took its origin from its habit of chiefly frequenting the cotton-fields, when that plant was cultivated in Barbados. It is recorded from the island of Grenada by Mr. Wells, and Mr. Lawrence remarks (*Proc. U.S. Nat. Mus.* p. 628, 1886) that this is an addition to the fauna of the Lesser Antilles. But apparently Schomburgk's list of the birds of Barbados, where this species is included, had been overlooked.

56. TRINGITES RUFESCENS (Vieill.).

The Buff-breasted Sandpiper is of sufficiently rare occurrence in Barbados not to have received a local name. Dr. Manning gave me an example which he shot in the autumn of 1887, and I have another, a male, which I procured at Chancery Lane on October 6, 1888. I have amongst the series in my collection a specimen from Barbados, collected by the late Lt.-Colonel Wedderburn, of the 42nd Highlanders (*circa* 1847). Mr. Massiah's description of this bird to me was quite sufficient to identify it even before I saw a specimen; he likened it to a miniature Bartram's Sandpiper, with peculiar markings under the wings, and he considered that individuals appeared annually on autumn migration in Barbados. Cory has hitherto only described it as 'accidental' in the West Indies, from the Island of Cuba.

57. NUMENIUS HUDSONICUS (Lath.). Crook-billed Curlew; Woodcock.

It arrives early in August, flying very often in pairs, but chiefly towards the middle of September. It is by no means so abundant a visitor as the next species, *N. borealis*. I obtained, however, several examples during the autumn of 1888.

58. NUMENIUS BOREALIS (Forst.). Chittering Curlew.

Arrives about the end of August, but passes more frequently in September. The first I obtained in 1888 was on September 5, when immense numbers passed over the island, though comparatively few alighted. The same day great flights of Golden Plover (*Charadrius dominicus*) and Longlegs (*Totanus flavipes*) arrived; I saw over a hundred of each of these species shot at one stand by a single gun.

Obs. I did not observe *N. longirostris*, nor does it appear to be known to the sportsmen of Barbados, who would at once recognize it, if it occurred, by its great length of bill.

59. ARDEA HERODIAS, Linn. Grey Gaulding.

This fine species is a regular autumn visitor, arriving in October and November in parties, sometimes consisting of from ten to twelve individuals. I shot a fine example at Chancery Lane on October 24, 1888; the outspread wings measured seventy inches from tip to tip. Dr. Manning, Mr. B. H. Belgrave, and other gentlemen sent me specimens during the autumn of 1888.

60. ARDEA EGRETTA, Gmel. White Gaulding.

A rare visitor. I procured one at Græme Hall swamp on July 4, 1888, an adult female, in beautiful plumage. It was alone at the time.

61. ARDEA VIRESCENS, (Linn.). Gaulding.

Resident, and tolerably abundant in those places where any protection is afforded. In the beautiful grounds of Codrington College it breeds freely, nesting on tall trees; it is there quite fearless, and the old birds come down from

their nests to the ornamental water in front of the building. The nest is a frail structure of twigs: the number of eggs two or three, of a pale green colour. This species is common at Valentia swamp, where I have disturbed as many as a dozen from a single tree at one time; but in most parts of the island it is persecuted at all seasons, and consequently has become very wary. I found the breeding season to be in May, June, and July.

62. PORZANA CAROLINA (Linn.). Two-penny Chick.

Though this Rail nowadays goes by the name of Two-penny Chick, the bird described by Hughes (1750) under the same appellation was undoubtedly a Grebe. This Rail is a regular visitor to Barbados during the months of October and November. When flushed from a swamp and driven to seek refuge in a dry place, it has a habit of running into holes or poking its head under cover, and in this situation I have seen it captured by hand.

63. GALLINULA GALEATA (Licht.). Red-seal Coot.

Resident. A few still lingered at Græme-Hall swamp in 1888, from whence I obtained a nest with seven eggs in the month of July, when I fully identified the bird. It used to be plentiful at several spots in the island, particularly so at Valentia swamp and at a pond on the Three Houses estate, but it has been exterminated, I think, in those places.

64. IONORNIS MARTINICA (Linn.).

This Purple Gallinule must be a rare and accidental visitor. I have a specimen shot by Dr. Manning in the autumn of 1887, and Lieutenant Venour, of the West India Regiment, informed me that he saw another captured in the same month and year by some boys with a dog, in the swamp below St. Ann's Fort.

65. FULICA AMERICANA, Gmel. White-seal Coot.

Resident. A few still lingered at Græme-Hall swamp as late as 1888, whence I procured an example in August. I am afraid it was one of the last of its race. Mr. A. M. McLean told me that twenty-five years ago he could remember both the Waterhen and Coot being abundant in the swamp. Mr. Spencer, the owner at that time, would not allow them to be molested and it was no uncommon occurrence to see twenty or thirty of both species swimming together on the open-water spaces in the swamp. The cutting down of the bush around Valentia swamp a few years ago banished them from there. The bird must soon be extinct as a resident in the island.

66. BERNICLA BRENTA. (Pallas.).

I think I am fully justified in including the Brent Goose as having certainly visited Barbados on one occasion. My authority is Mr. J. P. Massiah, J.P., who shot the bird in question at Chancery Lane on November 15, 1876. His accurate description leaves no doubt on my mind that the bird was of this species. During an experience of over thirty years Mr. Massiah has never seen but this one Wild Goose in Barba-

dos, nor could I hear from any other source of Wild Geese having been seen or obtained, except in this single instance.

67. DENDROCYGNA VIDUATA (Linn.).

A flock of twenty-seven of these beautiful Ducks appeared in Græme Hall swamp in September 1887; one that was slightly wounded was taken alive to Dr. Manning, who placed it in his aviary; a year subsequently I saw it alive and well. Cory records this species in the West Indies as only from Cuba, and there introduced.

68. QUERQUEDULA DISCORS (Linn.). Blue-winged Teal.

An annual visitor in considerable numbers, generally arriving about the first week in October, and continuing to do so at intervals till Christmas. I shot several examples.

69. SPATULA CLYPEATA (Linn.). Spoonbill.

An annual vistor in small numbers during the months of October and November. I have examples procured at Chancery Lane.

70. ERISMATURA RUBIDA (Wils.).

A male shot in the swamp at Chancery Lane on September 13, 1888, by Mr. W. Pearson is now in my collection. Another was obtained by Mr. I. Tinling at the same place in the fall of 1887. It is a rare straggler to the island. The diving powers of this Duck are remarkable. The beautiful shade of cobalt-blue which suffuses the upper mandible of the adult male bird fades very soon after death. The stomach of the bird shot by Mr. Pearson was full of grass-seeds.

71. FREGATA AQUILA (Linn.). Cobbler.

The local name given I have heard applied to the Frigate-bird in Barbados. It is included by Schomburgk in his list, and I have myself seen it floating over the island and passing at a great height. Mr. Massiah shot one some years ago at Chancery Lane.

72. PELECANUS FUSCUS (Linn.). Pelecan.

An irregular visitor, but sometimes, as in 1886 and 1887, appearing in flocks of hundreds. I saw two or three in the island during 1888. Lieutenant R. E. Stuart, R. A., fired at one near Needham's Point on October, 27 1888. The Père du Tertre, in his *Natural History of the Antilles* (Vol. ii, p. 271), mentions that a great mortality occurred amongst these birds in the year 1656 during the month of September, and that the shores of the islands of St. Lucia, St. Vincent, Bequia, and the Grenadines, were strewn with their dead bodies.

73. {SULA SULA (Linn.).
{SULA PISCATOR (Linn.). Booby.

I have seen Boobies outside Carlisle Bay, but as I was unable to obtain a specimen for identification, I cannot say to which of these species they belonged; probably both occur.

Schomburgk includes both of them in his list. The shores of the island do not seem to attract many sea-birds. I hardly ever saw one close in-shore; but the fishermen told me that when out flying-fish catching, they are often surrounded by crowds of Gulls, Boobies, Frigates, and Petrels, when from ten to twenty miles from Barbados. Any resident interested in adding to our knowledge of the ornithology of Barbados should instruct the fishermen to bring in specimens of the birds they meet with, and I am sure the list would be considerably increased by so doing, or, better still, if he had the fortitude, he should accompany the fishermen in their boats.

74. PHAETON ÆTHEREUS (Linn.).

I have seen Tropic-birds when entering and leaving Carlisle Bay on board the mail steamers: not having obtained an example I cannot state that this is the species with absolute certainty, but as it is the one which resides and breeds in the island of Grenada, in all probability it extends its flight to Barbadian waters. A Tropic-bird was captured after a gale in 1877 near Chancery Lane, but was not preserved.

75. LARUS ATRICILLA, Linn.

An occasional visitor. I have a specimen shot by Dr. Manning in the summer of 1887, and another shot on July 24, 1888, was brought to me in the flesh. As this bird is numerous, and breeds around the island of Grenada, it is somewhat singular that they so seldom visit Barbados, but this island apparently offers few attractions to sea-birds.

76. STERNA ANGLICA, Montagu.

I have a specimen of this Tern shot by Mr. Chase at Graeme Hall swamp on October 6, 1888, and another procured at the same place on the following day.

77. STERNA ANTILLARUM (Less.).

Obtained at Chancery Lane by Mr. Massiah on September 8, 1888, and another by Dr. Manning on October 17.

78. HYDROCHELIDON LEUCOPTERA (Schinz).

I obtained at Chancery Lane on October 21, 1888, an immature example of a Black Tern, which I took to be *H. lariformis* (Linn.), but on submitting it to Mr. Howard Saunders he came to the conclusion that it is a White-winged Black Tern. This species is of very rare occurrence in North America, only one having been hitherto obtained on that continent; it is an addition to the fauna of the West Indies.

79. HYDROCHELIDON HYBRIDA (Pallas).

In the fourth edition of Yarrell's *British Birds* (Vol. iii., p. 529), the editor, Mr. Howard Saunders, states that a mounted specimen, marked as obtained in Barbados, is in the British Museum, presented by Sir R. Schomburgk, who, however, did not include it in his list of the birds of that island.

80. STERCORARIUS CREPIDATUS (Gmel.).

An example of this species was brought to me alive on

July 10, 1888. I recorded the circumstances in *The Zoologist* for 1888, p. 350.

81. PUFFINUS AUDUBONI, Finsch.

A short notice of the breeding of this species has already been contributed to this Journal (*vide* 'The Ibis,' 1888, p. 60). It may be considered as a resident species, for on visiting the Bird-Rock in October several were captured in holes. It bred in considerable numbers this year, and the eggs were deeply incubated by the end of March.

82. PODICEPS DOMINICUS (Lath.).

Schomburgk includes this species in his list of the Birds of Barbados. Undoubtedly one species of Grebe, if not more, visits the island in autumn and winter. I did not procure a specimen but the description given me of a bird seen at Chancery Lane in 1887 undoubtedly referred to a Grebe.

[NOTE ADDED.—In Colonel Feilden's letter quoted at the head of this article, reference is made to the introduction into Barbados of the *Pied Carreau* or the Mocking Bird of Grenada (*Mimus gilvus*). Several specimens of this bird were obtained by Dr. Morris in May 1901 through the kind co-operation of Mr. William Broadway, the Curator of the Botanic Station at Grenada. In May 1902 a pair of these birds was nesting in an evergreen tree (*Ficus*) near the Garrison and another pair is seen in the neighbourhood of Chelston.

The Grass Canary referred to is common in some parts of the parish of St. Philip especially near the Crane. This bird is regarded as a recent introduction but so far its name has not been ascertained. In October 1902 a specimen of the Rice Bunting, No. 15 of Colonel Feilden's list (*Dolichonyx oryzivorus*), and of No. 62, (*Porzana carolina*) the Two-penny Chick were received by the Department from Mr. W. Lambert Phillips, the Treasurer of Barbados. On December 17 last Dr. Morris obtained from Captain Leukten of the s.s. *Dahome* a fine specimen of the Tropic-bird (*Phaeton æthereus*). This was found on board with a broken wing during a severe thunderstorm between Barbados and St. Vincent. It lived for several days and fed greedily, but unfortunately it was accidentally killed at Grenada.]

ADDITIONAL NOTES ON WEST INDIAN FODDERS.

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In the *Kew Bulletin* No. 95, November 1894, pages 373-87, there is an interesting paper on Tropical Fodder grasses, continued in No. 105, September 1895, pages 209-11. These articles were followed by some notes by myself in Nos. 113-114, May and June 1896, pages 115-18, containing analyses of Barbados sour-grass (*Andropogon pertusus*), *Chloris barbata*, Cent per Cent grass (*Panicum prostratum*), Rice grass (*Panicum colonum*), and of Hay grass (*Andropogon caricosus*).

The following analyses and notes are put forward as an extension of these articles and may prove of interest to West Indian stock owners.

GUINEA GRASS. (1)

Panicum maximum, Jacq. (P. jumentorum, *Pers.*)

The material analysed was cut when in flower, with the seed beginning to set. After sun drying, the results obtained were :—

Hay	...	29·0
Loss = Water	...	71·0
		100·0

Upon analysis the hay was found to contain :

Water	...	13·49	†(14·30)
Fat	...	·70	(1·34)
Protein (crude)*	...	4·11	(7·02)
Carbohydrates	...	38·05	(41·98)
Fibre	...	34·07	(27·01)
Ash	...	9·58	(7·75)
		100·00	

*True protein	2·62
Albuminoid ratio on crude protein	9·7
„ „ true „	15·2

(1) *Kew Bulletin* No. 5, November 1894, p. 382, contains a useful note on this grass.

† An analysis, No. 1153 recorded in U.S. Department of Agriculture Bulletin No. 11 ; *Analyses of American Feeding Stuffs*, p. 71.

From the above data the composition of the fresh grass is calculated as follows :—

Water	74·91
Fat	·20
Protein (crude)*	1·20
Carbohydrates	11·03
Fibre	9·88
Ash	2·78
	100·00
True protein	·76

PARA GRASS. (2)

Panicum muticum.

On drying this grass yielded:—

Hay	30
Loss = Water	70
	100

The analysis of the hay resulted as follows :—

Water	9·72
Fat	·67
Protein (crude)*	4·55
Carbohydrates...	46·16
Fibre	32·07
Ash	6·83
	100·00

*True protein	3·24
Albuminoid ratio on crude protein ...	10·5
„ „ true protein ...	14·8

From these data the composition of the fresh grass is found to be :—

Water	72·92
Fat	·20
Protein (crude)*	1·36
Carbohydrates	13·85
Fibre	9·62
Ash	2·05
	100·00
*True protein	·97

(2) A good description and history of this grass is given in *Kew Bulletin* No. 95, November 1894, p. 384.

BED GRASS, (SMUT, TUSSOCK, WIRE, OR PARAMATTA GRASS).[3]

Sporobolus indicus.

This grass occupies large tracts of waste land in Antigua and is one of the chief causes of destructive pasture fires. Its long, dry flower spikes, which persist after the seed has fallen, are unpalatable to stock and remain uneaten, covering large areas which thus present most unpromising grazing grounds. To remedy this state of things it has been a common practice to set fire to the pasture and destroy the old dry grass, whereupon a fresh growth of succulent herbage makes its appearance soon afterwards. The young succulent shoots are readily eaten by stock, hence this grass has a distinct value if properly treated. Doubtless it would be better if this grass were closely grazed or cut as the flower spikes made their appearance, so as to avoid the formation of the old, dry, tough flower stalks which now render useless so large an area of the Antigua pastures.

This grass is regarded as a fodder of some value in many other parts of the world, and as it grows on heavy clay lands, and upon poor soils where other and better grasses will not flourish, it might be worth while to give it more attention as an agent for improving heavy clay pasture lands. In some parts of Antigua this grass is being displaced naturally by Hay grass (*Andropogon caricosus*)[4] and as the latter is readily eaten by stock, even after it has flowered and dried, this constitutes a natural improvement of some consequence.

Duthie[5] includes *Sporobolus indicus* in his list of first-class fodder grasses and states: [6] 'It is found on clay soils, and is used as fodder when young. In Australia it is valued as an excellent pasture grass for alluvial soils; it stands drought well and is greedily eaten by stock. In the United States this grass, which is known there under the name of "Smut" grass, is of considerable value for grazing purposes if frequently cut or grazed down, but if allowed to remain untouched long, cattle and horses will not eat it unless very hungry, as it becomes tough and unpalatable.' Mr. J. N. Brashear of Port Gibson, Miss., quoted by Dr. Vasey, remarks in reference to this species: 'It is common all over our pasture lands, and is very hardy, standing any sort of weather. It grows well on almost any kind of soil, but does best on rich, moist bottom land. It is not used to any considerable extent for hay, but it makes splendid feed if cut while young. It will yield about 1½ tons per acre. It makes a splendid pasture plant, and that is what we generally use it for. Stock are generally fond of it until it goes to seed, and they sometimes use it when dry in winter.'

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(3) Barber. 'Notes on Antigua grasses'. *Supplement to Leeward Islands Gazette*, Sept. 1894.
Duthie. '*Fodder Grasses of Northern India.*

(4) Barber. 'Notes on Antigua Grasses.' *Supplement to Leeward Islands Gazette*, Sept. 1894. Watts. *Kew Bulletin* 1896, p. 116, *West Indian Bulletin*, Vol. I., p. 414.

(5) *The Fodder grasses of Northern India*, p. 72.

(6) *Loc. cit.* p. 40.

The sample analysed was cut when in full flower and yielded

Hay... ...	41·5
Loss = Water ...	58·5
	100·0

The hay contained

Water	10·73	(14·30)†
Fat	·61	(2·80)
Protein (crude)* ...	8·37	(10·55)
Carbohydrates ...	40·11	(44·28)
Fibre	32·76	(22·00)
Ash	7·42	(6·03)
	100·00	

*True protein ... 6·31
Albuminoid ratio on crude protein 5·0
" " true " 6·6

From this the composition of the fresh grass is

Water	62·92	(74·02)‡
Fat	·25	(1·24)
Protein (crude)* ..	3·47	(3·14)
Carbohydrates ...	16·65	(14·30)
Fibre	13·60	(5·20)
Ash	3·08	(2·01)
	100·00	

*True protein ... 2·62

This analysis, which reveals a remarkably close albuminoid ratio, indicates that the grass is one of great value if properly treated. There seems to be good reason to suppose that great improvement may be effected in those Antigua pastures where this grass is abundant. It should be cut and made into hay as soon as the flower spike is fully developed but before the seed has fallen. No dry flower stalks should be allowed to remain. The practice of burning is a clumsy and wasteful expedient to perform an operation which is worth carrying out with greater care and skill. It would seem that we have a good grass practically wasted for want of knowledge how to deal with it.

† An analysis, No. 1169, recorded in U.S. Department of Agriculture Bulletin No. 11; *Analyses of American Feeding Stuffs*, p. 71.

‡ An analysis, No. 407, recorded in U.S. Department of Agriculture Bulletin No. 11; *Analyses of American Feeding Stuffs*, p. 89.

HAY GRASS. (7)

Andropogon caricosus.

Attention has already been drawn to this grass which is rapidly spreading in Antigua, invading spots previously occupied by Bed grass (*Sporobolus indicus*) whereby a natural improvement in the pastures is taking place. It is an East Indian grass, introduced in some unknown manner into Antigua, where it appears to have found a congenial home.

This grass stands in striking contrast to Bed grass (*Sporobolus indicus*) and some others, in that stock will eat it after it has flowered and dried on the pasture, a fact which gives it additional value; for in this condition it may be cut and fed to the animals.

In order to compare the dry grass in this condition with the grass cut during the early stages of the flowering period, a sample of dry grass was collected and analysed. The result is as follows. The analysis of hay from fresh grass is reproduced from the *Kew Bulletin* 1896, p. 117, for comparison.

	Dried grass.	*Hay, cut young.*
Water	11·14	12·14
Fat	·67	·82
Protein (crude)* ...	2·14	4·79
Carbohydrates	43·23	38·61
Fibre	33·47	34·57
Ash	9·35	9·07
	100·00	100·00
*True protein	1·84	2·81
Albuminoid ratio on crude protein	21·0	8·5
„ „ true „	21·4	14·3

From this it appears that the old grass affords a very fair fodder, though not so good as the grass early in the flowering period: the greatest difference lies in the diminished protein in the old grass with consequently a wider albuminoid ratio.

GUINEA CORN.

Sorghum vulgare.

Green fodder, cut from ratoons. Owing to its succulent character, this was dried artificially at a gentle heat and gave

Hay	20
Loss = Water ...	80
	100

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(7) Barber. 'Notes on Antigua Grasses,' *Supplement Leeward Islands Gazette*, Sept. 1894.
Watts. *Kew Bulletin* 1896, p. 116, *West Indian Bulletin* Vol. I, p. 413.

The composition of the hay was

Water	11·43
Fat	1·44
Protein (crude)*	8·00
Carbohydrates	45·98
Fibre	25·02
Ash	8·13
	100·00

*True protein	7·35
Albuminoid ratio on crude protein	6·2
„ „ true „	6·7

Whence the composition of the fresh fodder was

Water	82·28
Fat	·29
Protein (crude)*	1·60
Carbohydrates	9·20
Fibre	5·00
Ash	1·63
	100·00

*True protein	1·47

Stylosanthes procumbens.

This little leguminous plant is common in Antigua† upon soils derived from the limestone, and is an important constituent of the pastures of the limestone area. It forms an excellent low-bite for sheep. It is of a seasonal character, being abundant in the pastures from about July to January, after which it is not conspicuous.

The sample analysed was cut when in flower and fruit and yielded

Hay	39
Loss = Water ...	61
	100

The analysis of the hay afforded the following figures :—

Water	11·94
Fat	·75
Protein (crude)*	13·32
Carbohydrates	36·05
Fibre	30·37
Ash	7·57
	100·00

*True protein	9·59

† It also occurs in St. Vincent, Grenada and Barbados. In Grenada it is known as 'clover.' In Barbados it is very common on waste lands, and is sometimes called 'small creeping trefoil.'- [Ed. W.I.B.]

Albuminoid ratio on crude protein	2·8
„ „ True „	3·9

Whence the composition of the fresh fodder was

Water	65·66
Fat	·29
Protein (crude)*	5·19
Carbohydrates	14·07
Fibre	11·84
Ash	2·95
	100·00

*True protein ... ... 3·74

The relatively high proportion of the protein indicates that it is a useful fodder comparable with lucerne. Its value is also indicated by the fact that the albuminoid ratio is closer than that of most other green fodders, that of lucerne being about 3·1 when calculated on the crude protein.

SUGAR-CANE TOPS.

These constitute the most important of all fodders in the sugar-producing colonies. During crop time they are given to the animals in a fresh condition and are excellent fodder. Towards the close of the crop season considerable quantities of these tops are made into a rough kind of hay by partial drying followed by stacking in ricks or 'top heaps,' as they are locally called.

As a good deal of fermentation goes on in these ricks or heaps, amounting in badly packed heaps to actual decay, it has been suggested that perhaps cane tops thus preserved are very imperfect fodder, that the method is accompanied by great waste, and that it would be preferable to make ensilage.

In order to have data for a discussion of the points thus raised, analyses were made of two lots of tops from top heaps, the first lot consisting of selected tops representing the result of careful packing and successful preservation, the other lot being unselected and taken at random. In these latter the butts had decayed to some extent. For comparison an analysis was made of fresh tops.

COMPARATIVE COMPOSITION OF DRIED CANE TOPS FROM TOP HEAP, AND FRESH TOPS.

	Selected.		*Ordinary.*		*Fresh Tops.*	
Leaves.						
Water	13·31	Leaves constitute 81·52% of top.	11·83	Leaves constitute 87·66% of top.	44·04	Leaves constitute 69·69% of top.
Fat	·46		·58		·21	
Protein (crude)*	2·71		3·08		1·12	
Carbohydrates	35·38		41·81		12·59	
Fibre	23·94		28·20		9·79	
Ash	5·72		7·07		1·94	
True protein ...	2·48		2·92		·88	

	Selected.		Ordinary.		Fresh Tops.	
Butts.						
Water	10·52	Butts constitute 18·48% of top.	5·77	Butts constitute 12·34% of top.	24·37	Butts constitute 30·31% of top.
Fat	·12		·11		·05	
Protein (crude)*	1·10		·81		·23	
Carbohydrates	4·31		3·25		4·04	
Fibre	1·93		1·63		1·33	
Ash	·50		·77		·29	
	100 00		100·00		100·00	
*True Protein	·74		·64		·18	

Composition of Whole Tops.

	Selected.	Ordinary.	Fresh Tops.
Water	23·83	17·60	68·41
Fat ..	·58	·69	·26
Protein (crude)†	3·81	3·89	1·35
Carbohydrates	39 69	45·06	16·62
Fibre	25 87	24·92	11·12
Ash	6·22	7·84	2·23
	100·00	100·00	100·00
† True protein	3 17	3·56	1·06
Albuminoid ratio on crude protein	10·8	12·0	12 8
Albuminoid ratio on true protein	12·9	13·1	15·8

For closer comparison it is preferable to calculate the results on the dry substance (*i.e.* water-free.) We then obtain :

	WATER-FREE COMPOSITION OF CANE TOPS FROM TOP HEAP.		WATER FREE COMPOSITION OF FRESH TOPS.
	Selected.	Ordinary.	
Fat	·76	·84	·82
Protein (crude)	5·01	4·72	4·26
Carbohydrates	52·11	54·69	52·67
Fibre	33·96	30·24	35·20
Ash	8·16	9·51	7·05
	100·00	100·00	100·00
True protein ...	4·16	4·32	3·47

The differences are small and indicate that the cane tops may be preserved satisfactorily in this manner.

One factor, however, requires to be taken into considera-

tion, and that is the palatability. Should the changes which take place during the drying and storing in the manner under discussion render the fodder unpalatable, or repugnant, to animals, it is clear that the process is not to be recommended. This, however, does not appear to be the case, or to a small extent only, for cattle readily eat the tops thus preserved, particularly when cut into chaff and sprinkled over with molasses, to replace the sugar lost by fermentation.

Under the circumstances of the sugar industry of the Leeward Islands there is no difficulty in saving a very large quantity of useful fodder. In order to preserve the cane tops it is necessary that they be allowed to dry on the cane fields until they have formed a rough sort of hay; they are then tied in bundles and closely packed in ricks or heaps, some skill being requisite in order to pack them sufficiently closely. This fodder has considerable value and warrants the expenditure of some care in providing an adequate supply for the stock of a sugar estate in the period between the crop seasons.

Under these circumstances there does not seem to be any great inducement to convert cane tops into ensilage, whatever may be the position with regard to ensilage with other fodders.

In a tropical country it appears reasonable to suppose, that it will be more economical to preserve fodder in the form of hay rather than in the form of ensilage. The practice of making ensilage offers to the farmer of rainy districts in temperate climates a means of saving a fodder crop which runs a risk of being ruined in an attempt to make hay. In the West Indies, in most places there is little difficulty in making hay, and consequently little motive in making ensilage. I attach small importance to the arguments based upon the increased digestibility of ensilage, for this at present is a matter of conjecture.[8] Moreover, even if the digestibility of the fodder is increased by five per cent., it is probable that it will be found an easier matter to give the animals five per cent. more hay than to incur the expense of building and working a silo.

Of course there may be certain rainy districts where it may be necessary to make ensilage rather than hay, and there may be certain succulent crops which it may be preferable to convert into ensilage but, looking at the question broadly, it is safe to assert that, in a moderately dry tropical country hay making is preferable to ensilage. In support of this view I may quote Dr. J. A. Voelcker (*Report on the Improvement of Indian Agriculture*, p. 187): 'I have gone at some length into the silage question because I differ entirely from the opinions of one of my predecessors, to the effect that India is the great field for the development of ensilage. That it is the field for hay making I am much more ready to think. With a sun and climate such as exist over the greater part of India, I cannot see how it could well be otherwise. Hay requires no making, for it makes itself. Silage, I repeat, will only be useful when, by means of it, can be saved what would otherwise be lost.'

(8) See Whitman & Hall, *Bulletin No. 77*, U.S.A. Department of Agriculture. *The Digestibility of American Feeding Stuffs.*

It is perhaps almost a matter of misfortune that in some districts fodder is at times so abundant as to give the planter little concern, or even to occasion trouble in the form of invading weeds, while in a period of drought it becomes so scarce that animals may die for want of it. This superabundance at times leads to carelessness and disregard for the future: little or no hay is made beyond the 'top-heaps' above mentioned.

I believe that the introduction of a system of hay making would result in better pastures, better cattle, and increased wealth in the country.

Note.—Crude protein is the total nitrogen multiplied by 6·25. True protein was determined by Stutzer's process.

$$\text{Albuminoid ratio} = \frac{\text{Carbohydrates} + (\text{Fat} \times 2\cdot5)}{\text{Protein.}}$$

THE CLIMATOLOGY OF ANTIGUA.

Mr. W. H. Alexander of the United States Weather Bureau Service undertook a review of the climatological data collected at the Government Laboratory, Antigua. His results are published in the *Monthly Weather Review*, the official organ of the Weather Bureau of the United States Department of Agriculture, for April 1901, pages 165-7.

Mr. H. H. Kimball of the same service discussed the observations in detail in an article 'On the Seasonal Variations in the Climate of Antigua, West Indies.' in the same volume of the *Monthly Weather Review*, pages 168-73, with interesting tables showing the various meteorological conditions for each month of the year for the period 1890-1900.

It is desirable to place on record, for the convenience of the readers of the *West Indian Bulletin*, the salient points of the papers referred to. The following extracts are therefore reproduced :—

THE CLIMATOLOGY OF ANTIGUA.

'The island of Antigua lies to the eastward of St. Kitt's in latitude 17° 5' north, longitude 61° 50' west. It contains an area of 108 square miles and is circular in form, being some 70 miles in circumference. The coasts are indented by numerous bays, and being high and rocky, are quite dangerous to navigation. The surface of the island is level, in the main; the highest point, McNish Mountain, is only 2,200 feet above sea level. The hills are probably less than 1,500 feet in elevation. Owing to a light rainfall the elevated portions of the island are not clothed with that luxuriant tropical vegetation to be seen in other of the Leeward Islands such as St. Kitt's, Montserrat, and Dominica, but presents to the eye a rather desolate, uninviting appearance. The valleys, however, stand in marked

contrast to the hills, being arrayed in all the beauty and vernal richness of a tropical climate. There are no rivers, and but few springs, and these brackish. The people are dependent upon rainfall for a water supply, and have in former times suffered great loss and inconvenience from droughts. About one-third of the land is suitable for agricultural purposes.

'As regards its geological structure, and in accordance with the character of its surface, it may be divided into three portions. In these three divisions marked contrasts are exhibited in their geological relations. On one side, the western, the rocks are of an igneous character, denoting violent action, akin to volcanic, but without actual eruption: on the other side, the eastern, the character of the rocks is totally different, being chiefly calcareous, freestone and limestone; in the middle space, which is a plain, bordered on both sides by hills, both kinds of action may be said to be exhibited, the former in the indurated clays and silicious cherts, the latter in the numerous petrifactions (wood and coral) imbedded in the soil.

'The soils of the island are not less varied than its rocks: stiff clays may be considered as predominating in the western division, lighter ones and calcareous marls in the eastern and middle. These are generally productive, especially the marls, of extraordinary fertility. (C. A. Harris.)

'The climate of Antigua for a tropical one is decidedly healthful, and excepting for the hot months is most agreeable. The remarkable dryness of the atmosphere renders it highly favourable for people subject to chest diseases, which are almost unknown among Antiguans. The prevailing diseases of the island are confined almost entirely to the blacks and may be attributed to uncleanly habits, bad diet, and neglect.

'St. John's, the principal town of the island, has a population of about 9,500, and is situated upon the north-west coast. The town covers an area of 150 acres of land and is built upon a slight declivity toward the sea. It is not only the seat of the island government but of the general government of the Leeward Islands as well. The population of the island in 1881 was 34,964, and the probabilities are that the present population differs very little from that figure.

'The agriculturist is mainly engaged in the cultivation of the sugar-cane from which he obtains sugar, molasses and rum. The average crop is about 12,000 hogsheads. The soil is very suitable for the growing of canes, which live and thrive even under the most adverse circumstances. The labourers, when they can get the ground, cultivate for their own use small crops of yams, potatos, Guinea corn, etc. The wages of a field labourer vary to some extent, but generally are between 16 and 20 cents per day for a man; for a woman 12 to 16 cents per day is the usual pay. Domestic servants are paid $4 to $8 per month for a man, and $2.40 to $4.80 for a woman. Mechanics get from 36 to 48 cents per day. On account of the low wages and the limited demand for labourers, especially field labourers, there has been a steady emigration from the island of late years.

'For more than ten years Mr. Francis Watts, Chemist and

Government Analyst for the Leeward Islands, has kept at Antigua, in connexion with his other work, a complete series of meteorological records and has now kindly placed the same at my disposal. Mr. Watts being not only a scientific man but a close student of meteorology as well, has furnished the climatologist with material of more than ordinary value. The data were compiled by Mr. Watts himself or under his immediate supervision. I have worked the records into the accompanying tables.

'The data bearing upon the rainfall of Antigua are very complete and, to me, at least, very interesting. A careful study of the accompanying tables will reveal to the thoughtful many interesting points. Slight discrepancies in the means of the various tables may appear, but these were unavoidable, being the result of the various combinations and methods employed in obtaining the means, some of which were computed by Mr. Watts and some by myself. These differences, however, are immaterial in this connexion. The means of Table III. are, perhaps, slightly too great, for the reason that the period is not only short (twelve years), but contains the phenomenally wet year of 1889, when the mean for the island was about 60 per cent. above the normal.

'Referring to Table V., we find that of the twenty-six years there represented thirteen were below the normal and thirteen were above. The maximum deficiency, 17·22 inches, occurred in 1875, and the maximum excess, 27·50 inches, in 1889. Then too, I cannot refrain from inviting attention to the secular means in Table III. which shows a peculiar variation in the monthly averages beginning with May and concluding with December, while the departures in Table IV. reveal in a conspicuous manner the period of large and small departures. For instance, the six years from 1876 to 1881 show very slight departures from the normal, but for the two following years 1882 and 1883, the departures are very large, one above and one below the normal. Then comes another period of five years of nearly normal rainfall, followed again by two years of abnormally large departures, one above and one below the normal, and so on.

'Taking 12,000 hogsheads of sugar as an average crop, and 46·00 inches of rain as the average fall, it would appear that for each inch of rain that falls the island produces 261 hogsheads of sugar.

* * * *

SEASONAL VARIATIONS IN THE CLIMATE OF ANTIGUA.

'In the case of a tropical oceanic climate like that of Antigua where the variations from year to year, unlike those of the higher latitudes, are extremely small, excepting perhaps the variations in the rainfall, the changes from month to month, or from season to season, are of the greater interest. (See Table IV).

'The monthly averages of pressure show a maximum in February and again in June and July, with a decided minimum

in October and November; the summer maximum is much more pronounced than at other West Indian stations. The winter maximum is easily explained by the southward movement at this season of the belt of high pressure encircling the globe north of the equator; the summer maximum may be attributed to the building up of the area of high pressure over the Atlantic which reaches a maximum in July. The principal minimum of the year occurs a month later than in Havana, and is attributable to the combined effect of the northward movement of the high pressure belt, and the contraction of the Atlantic high pressure area.

'It is interesting to notice that the average daily wind movement follows much the same law as the average monthly pressure, showing a decided maximum in June and July, and a decided minimum in October. The wind direction data is not of a character that enables us to study changes of direction from season to season, since the prevailing direction only is given, that is the direction observed the greatest number of times during the month, and this is almost always from the east. We notice, however, that north-easterly winds prevail less frequently in summer than in winter, and therefore infer that the prevailing easterlies, in a latitude where we would naturally expect north-easterlies, are due to the anticyclonic circulation about the Atlantic high to the east of Antigua. While the full observations of wind direction for Antigua would no doubt show the same strong north-easterly component observed at other West Indian stations, it must be admitted that the influence of the Atlantic high pressure area on both the atmospheric pressure and the winds of Antigua is very marked.

'The monthly averages of temperature vary less than 3° from the annual average. February is the coldest month and August the warmest, but the highest temperatures do not occur till September and October. Similarly, the minimum monthly rainfall for the whole island occurs in February, and the maximum in September. . . . . . .

The data 'emphasize the importance of proper exposure of instruments, if records of value in the study of the climatology of a place are to be obtained. The increase of nearly 3° in the annual mean minimum thermometer reading, due to a change of exposure in November 1895, is as great as the differences in the average annual mean minimum temperatures for the different islands of the Windward group. Any error in recording the temperature also enters into the relative humidity data, and a comparison between the climates of the different islands is thus made difficult.'

TABLE I.

MONTHLY RAINFALL AT ST. JOHN'S, ANTIGUA, FROM APRIL 1866 TO DECEMBER 1900, INCLUSIVE.

Year.	Jan.	Feb.	March.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Annual.
1866	...	...	...	2·03	1·21	3·30	2·12	2·25	3·14	6·71	2·19	1·37	24·32
1867	2·15	3·56	0·63	6·11	11·02	10·36	4·74	2·95	7·52	3·20	6·46	5·22	63·92
1868	2·08	1·50	1·63	1·60	2·24	2·12	3·89	3·08	9·85	8·64	3·54	2·34	42·51
1869	2·33	2·63	2·00	0·88	1·86	5·70	2·04	3·77	6·83	2·80	5·22	2·21	38·27
1870	4·60	0·84	2·85	0·79	1·64	2·13	5·83	6·82	2·55	4·35	3·04	2·28	37·72
1871	3·47	1·49	3·05	4·20	3·30	1·81	2·93	2·52	4·01	3·40	1·97	2·82	34·97
1872	1·64	0·68	1·68	1·04	1·52	2·22	5·77	2·16	11·86	5·87	4·60	5·19	44·23
1873	4·05	1·17	4·22	1·11	1·83	1·39	1·75	4·63	5·84	6·62	1·92	2·52	37·05
1874	1·95	1·79	1·50	2·46	3·10	1·85	3·33	5·98	7·87	4·49	3·68	2·43	40·43
1875	2·50	2·83	3·52	1·24	1·48	2·99	3·06	4·71	3·16	6·11	1·08	7·49	40·17
1876	4·01	1·58	4·64	4·39	9·44	5·89	4·53	3·36	4·32	2·76	2·11	1·96	48·99
1877	2·08	4·06	0·44	8·45	2·64	6·58	3·69	2·24	3·99	6·90	6·35	4·16	51·58
1878	3·57	1·51	3·99	2·53	11·20	2·29	7·95	6·65	9·82	5·90	5·39	1·88	62·68
1879	3·68	5·75	1·81	5·47	11·39	6·90	5·96	12·15	2·78	8·66	7·71	4·22	76·43
1880	11·09	2·83	2·13	6·94	9·46	4·46	10·28	3·96	3·74	3·72	4·84	3·36	66·81
1881	2·77	2·71	0·66	4·13	8·01	10·65	5·23	8·70	4·79	12·65	6·25	1·30	66·85
1882	2·52	1·91	0·57	1·37	1·44	2·60	4·46	5·45	5·52	7·45	3·22	6·15	42·66
1883	3·75	4·18	2·27	4·64	6·76	5·08	3·63	6·19	3·13	10·70	10·12	8·69	69·14
1884	2·83	2·69	3·39	2·39	4·72	3·75	7·32	2·44	7·37	5·93	6·05	4·71	58·59
1885	2·59	1·59	1·47	2·25	1·57	2·04	3·31	9·85	2·63	9·87	9·28	4·70	51·15
1886	2·69	2·50	1·67	4·45	2·25	3·83	4·57	5·58	9·18	4·33	4·20	2·79	48·14
1887	3·16	2·76	1·32	0·54	3·84	7·90	4·43	6·11	7·32	6·31	4·55	1·65	49·89

TABLE I.—(*Concluded.*)

MONTHLY RAINFALL AT ST. JOHN'S, ANTIGUA, FROM APRIL 1866 TO DECEMBER 1900, INCLUSIVE.

Year.	Jan.	Feb.	March.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Annual.
1888	3·01	2·14	2·02	4·15	1·84	5·57	7·19	7·46	4·72	6·09	4·31	1·62	50·12
1889	2·83	5·36	4·03	8·27	12·29	17·51	4·18	7·08	13·71	6·01	4·56	3·23	89·06
1890	5·21	1·00	2·51	9·72*	3·06	1·30	3·79	5·53	5·26	3·32	1·56	1·96	44·22
1891	5·38	2·03	0·57	4·85	3·29	4·47	7·78	5·73	5·31	7·98	7·90	3·11	57·40
1892	5·64	0·91	1·02	1·59	1·99	3·77	3·87	2·58	4·68	5·22	10·03	1·99	43·29
1893	2·78	1·98	3·28	2·61	1·85	2·68	4·12	2·82	4·89	7·98	1·63	3·84	40·49
1894	2·89	1·69	1·18	6·36	3·60	1·30	2·60	1·09	7·41	5·13	8·05	6·70	48·00
1895	2·92	0·73	1·60	2·98	10·47	2·58	5·08	7·48	7·67	5·57	5·25	10·90	63·23
1896	3·34	2·71	2·55	2·21	6·20	7·22	6·61	4·85	3·18	4·95	15·54	5·21	64·57
1897	3·02	3·24	6·24	1·87	6·88	2·68	7·19	2·42	4·56	2·85	2·82	4·10	47·87
1898	2·94	1·22	2·78	0·93	3·17	2·99	9·64	6·45	14·85	4·80	9·72	3·69	63·18
1899	3·97	1·83	1·11	0·84	1·08	3·30	8·40	9·23 †	10·48 †	2·63	7·72	2·64	53·23
1900	1·72	1·84	1·18	2·13	3·89	2·33	4·91	6·48	2·27	10·28	3·10	3·26	43·39
Means of 34 years‡	3·39	2·27	2·22	3·40	4·69	4·42	5·12	5·25	6·27	5·98	5·38	3·83	52·21

* Beginning with April, 1890, the record was kept at the Government Laboratory: before this date at the Public Library.

† Partly estimated, gauge blown over.

‡ The means are for the 34 years from 1867-1900, inclusive.

TABLE II.

SUMMARY OF METEOROLOGICAL RECORDS AT ST. JOHN'S, ANTIGUA, FOR THE TEN YEARS 1891–1900.

Year.	Mean air Pressure.		Mean Temperature. Dry.		Mean Temperature. Wet.		Mean Dew Point.		Relative Humidity.		Wind. Prevailing Direction.		Wind. Average Daily Movement.	Precipitation. Total Amount.	Precipitation. No. days with ·01 in. or more.	Number of Thunder storms.	Number of Earth-quakes.
	9 a.m.	3 p.m.	9 a.m.	3 p.m.	9 a.m.	3 p.m.	9 a.m.	3 p.m.	9 a.m.	3 p.m.	9 a.m.	3 p.m.					
	Inches	Inches							Per cent.	Per cent.			Miles.				
1891	30·075	30·023	80·9	82·9	74·4	74·7	70·0	70·0	74	68	E	E	...	57·40	267	21	9
1892	30·097	30·035	81·4	83·2	73·8	74·3	69·0	69·0	70	66	E	E	...	43·29	261	11	5
1893	30·046	29·979	81·0	83·1	74·3	74·9	70·0	69·0	73	68	E	E	...	40·49	256	22	3
1894	30·077	30·007	80·8	83·1	73·9	74·7	70·0	69·0	72	67	E	E	209·8	48·00	247	13	10
1895	30·070	30·004	80·1	83·4	74·7	75·6	70·0	70·0	75	69	E	E	207·0	63·23	252	19	8
1896	30·089	30·019	81·4	84·2	74·6	75·5	70·0	70·0	73	67	E	ENE	196·4	64·57	239	17	5
1897	30·100	30·031	81·8	84·5	74·9	75·7	70·0	70·0	72	67	E	E	180·6	47·87	236	11	8
1898	30·063	29·998	81·8	84·4	74·3	75·0	69·0	69·0	70	65	E	E	186·4	63·18	229	14	7
1899	30·065	29·994	81·6	84·6	74·3	75·2	70·0	69·0	71	64	E	E	185·6	53·23	221	17	8
1900	30·065	30·002	82·2	84·3	74·6	74·9	70·0	70·0	70	66	E	E	170·3	43·39	194	8	11
Secular Means	30·075	30·009	81·3	83·8	74·4	75·0	69·8	69·5	72	67	E	E	190·9	52·46	240·2	15·3	7·4

TABLE III.

MONTHLY AND ANNUAL AVERAGE RAINFALL (IN INCHES AND HUNDREDTHS) ON THE ISLAND OF ANTIGUA FOR A PERIOD OF TWELVE YEARS 1888-1899, INCLUSIVE.

Year.	No. of Station.	January.	February.	March.	April.	May.	June.	July.	August.	Sept'mber.	October.	November.	December.	Annual.
1888	47	2·09	1·83	1·44	3·54	2·44	3·48	6·06	7·24	5·30	5·40	3·83	1·52	44·02
1889	51	1·70	5·07	4·05	6·96	9·86	14·36	3·10	5·27	11·15	5·17	3·33	3·69	73·51
1890	46	3·60	1·18	1·84	7·53	2·31	1·04	2·52	3·72	5·23	2·82	1·33	2·57	35·79
1891	45	3·67	2·24	0·34	2·71	1·87	4·02	9·95	5·63	3·63	7·01	6·70	1·86	50·01
1892	53	5·77	0·82	0·86	1·18	2·35	3·27	3·15	2·16	4·33	4·35	8·09	1·31	38·53
1893	54	1·78	1·50	2·66	2·10	2·04	2·09	4·60	2·99	6·53	8·42	1·16	2·83	38·69
1894	68	1·89	1·03	1·29	2·76	2·75	1·31	1·57	1·38	5·31	5·66	5·26	8·58	38·87
1895	69	2·30	0·51	1·45	2·30	7·94	1·57	3·65	6·46	7·41	5·13	5·08	8·83	52·91
1896	56	3·10	1·71	2·08	1·54	6·33	7·33	5·89	4·88	2·88	7·11	13·66	3·55	59·85
1897	54	2·28	2·24	6·18	1·15	5·91	2·25	6·01	1·70	3·73	1·86	2·68	3·69	39·67
1898	66	2·08	1·19	2·39	0·95	2·00	1·95	6·69	5·09	12·30	3·29	8·29	2·68	48·85
1899	63	3·17	1·20	0·86	0·46	1·17	2·67	7·50	7·14	10·54	4·98	5·60	1·54	47·50
SECULAR MEANS	...	2·79	1·71	2·12	2·76	3·91	3·78	5·06	4·47	6·53	5·10	5·49	3·55	47·35

TABLE

MEANS FOR 11 YEARS *

	Jan.	Feb.	Mar.	April.
Barometric pressure ... 9 a.m.	30·10	30·13	30·10	30·09
3 p.m.	30·03	30·06	30·02	30·02
Means of 9 a.m. and 3 p.m. pressure	30·06	30·09	30·06	30·06
Dry Thermometer ... 9 a.m.	78·3	77·8	79·1	80·4
" ... 3 p.m.	81·8	81·5	82·1	82·6
Mean maximum Temperature ...	83·7	83·4	84·0	85·0
" Minimum "	70·2	70·1	70·5	72·0
" Temperature (Max. + Min.) ÷ 2	76·9	76·8	77·2	78·4
Highest Temperature (absolute) ...	88	89	90	92
Lowest " (absolute) ...	61	60	60	60
Wet Thermometer ... 9 a.m.	71·7	70·5	70·9	72·6
" " ... 3 p.m.	72·6	71·5	72·0	73·5
Dew Point ... ... 9 a.m.	67	65	66	67
" " ... ... 3 p.m.	67	65	65	67
Relative Humidity ... 9 a.m.	73	70	67	69
" " ... 3 p.m.	65	61	61	65
Average Daily Wind Movement ...	194·2	207·5	209·1	205·4
No. of days with ·01 or more ins. rain	22·8	17·5	16·1	13·9
No. of Thunderstorms	0·2	0	0·2	0·2
No. of Earthquakes	0·3	0·4	1·3	0·3

* Abstracted from Tables 1-21 of Mr. Kimball's article.

IV.

(1890-1900.)

May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Annual.
30·07	30·11	30·10	30·05	30·04	30·01	30·02	30·07	30·08
30·02	30·06	30·06	30·01	29·98	29·93	29·94	29·99	30·01
30·04	30·08	30·08	30·04	30·01	29·97	29·98	30·03	30·04
82·3	83·1	83·1	83·9	83·7	83·3	81·4	79·8	81·3
83·6	84·8	85·2	85·7	85·5	84·7	83·3	82·6	83·6
85·9	86·9	87·2	88·1	88·2	87·7	85·9	85·0	85·0
73·7	75·2	75·4	75·9	74·8	74·2	73·0	71·5	73·0
79·8	81·1	81·3	82·0	81·5	80·9	79·4	78·2	79·5
90	91	92	92	93	93	92	90	93
66	69	69	70	69	67	65	63	60
74·8	76·0	76·2	76·9	77·2	76·8	75·2	73·5	74·4
75·4	76·1	77·1	77·6	77·6	76·7	75·8	74·4	75·0
70	71	72	73	73	73	71	69	70
70	71	72	72	73	72	71	69	70
71	72	73	73	75	74	75	74	72
68	67	69	69	70	69	71	68	67
209·6	237·3	243·8	214·8	158·4	119·8	153·2	136·0	160·0
17·0	20·1	23·7	22·5	21·0	21·5	23·2	22·5	242
0·8	2·4	2·6	2·5	2·6	3·2	0·6	0·2	15·3
0·5	0·5	0·5	0·7	0·9	0·9	0·5	0·6	7·4

TABLE V.

AVERAGE RAINFALL ON THE ISLAND OF ANTIGUA FOR A PERIOD OF TWENTY-SIX YEARS, 1874-94, INCLUSIVE.

Year.	Number of Station	Rainfall.	Departure from the normal.
		Inches.	Inches.
1874	41	31·16	− 14·84
1875	40	28·78	− 17·22
1876	36	41·98	− 4·02
1877	38	49·05	+ 3·05
1878	53	47·11	+ 1·11
1879	52	61·54	+ 15·54
1880	46	49·69	+ 3·69
1881	44	53·75	+ 7·75
1882	45	33·04	− 12·96
1883	56	55·51	+ 9·51
1884	56	43·98	− 2·02
1885	53	43·39	− 2·61
1886	55	47·78	+ 1·78
1887	50	43·68	− 2·32
1888	47	44·23	− 1·77
1889	50	73·59	+ 27·59
1890	45	33·00	− 13·00
1891	45	50·01	+ 4·01
1892	58	38·53	− 7·47
1893	54	38·69	− 7·31
1894	68	38·87	− 7·13
1895	69	52·91	+ 6·91
1896	56	59·85	+ 13·85
1897	54	39·67	− 6·33
1898	66	48·85	+ 2·85
1899	63	47·50	+ 1·50

AGRICULTURAL EFFORTS AT DOMINICA.

On the occasion of the recent visit of Dr. D. Morris, C.M.G., the Imperial Commissioner of Agriculture, to Dominica, he was invited to address a special meeting of the Agricultural Society in the Court House on December 5.

In the absence of the President (Hon. Hesketh H. Bell) the Chair was taken by his Honour W. H. Whyham, the Acting Administrator.

The following is a summary of the address delivered by Dr. Morris together with a brief report of the discussion furnished by the Hon. Secretary (A. K. Agar, Esq.):—

I had the pleasure of first addressing a meeting of planters in Dominica sixteen years ago. I addressed a second meeting twelve years ago; and a third successful meeting towards the latter end of 1899. This is, therefore, the fourth time I have had the privilege of standing here and contributing my share towards the development of the agricultural resources of Dominica.

I regret the absence of the President of this Society, and especially as his Honour has, himself, taken so deep and practical an interest in all matters of an agricultural character.

From the returns that have been kindly placed at my disposal by the Treasurer, I find the value of the exports, the produce of the island, has been steadily increasing. The average for the last three years is £67,000. I notice that, at present, over a million pounds of cacao is exported. This is a gratifying fact which, coupled with the steady increase in the exports of fresh and pickled limes, raw and concentrated lime juice, expressed and distilled oils, shows clearly that the cacao and lime industries of Dominica are in a flourishing condition The export of oranges, on the other hand, appears to have fallen off. In 1899 there were exported about a million and a half oranges. Two years later the exports were only about 700,000. It is probable that, although fewer oranges are exported, the prices realized are better than formerly. Coffee, once one of the principal exports of Dominica, has also been declining. The present prices are ruinous: nevertheless the cultivation should not be abandoned. The conditions are eminently favourable for the production of fine coffee, almost equal to the best Blue Mountain coffee of Jamaica. A new coffee, introduced lately from Western Africa and known as 'Sierra Leone' coffee, is very prolific and hardy even at sea level. This produces a small well-flavoured bean almost exactly resembling Mocha coffee. It deserves attention.

It is admitted that in Dominica and elsewhere in the West Indies we are entirely an agricultural community, therefore all our energies should be directed to encouraging the skilful treatment of the soil and raising crops that, by equally skilful curing and packing, might obtain remunerative prices in the markets of the world. A good deal has been done, already, in this direction, but a good deal still remains to be done. I regard the organization and efficient working of this Society as especially

useful in that direction. As far as the Imperial Department of Agriculture can assist you, I can promise its cordial co-operation and especially by means of the agencies already established by it in this island.

BOTANIC STATION.

At the Botanic Station you have not only a beautiful park and garden, but extensive nurseries, where all sorts of economic plants are raised and distributed at something less than the cost price. The number of plants, annually distributed, is about 60,000. Many of these are budded orange plants, lime plants, and the best varieties of cacao plants. As regards lime and cacao plants, I believe, in many cases, the planters could, with advantage, raise these themselves. Possibly to persons in remote districts cacao pods would travel better than plants. I suggest this for consideration. The Department will do all it can to assist especially those opening up new lands, as they are not in a position immediately to grow their own plants.

I believe the services of the Botanic Station in this island are greatly appreciated by members of the planting community as also the devotion ot the Curator and his colleagues, and their readiness at all times to afford assistance and advice in regard to agricultural matters.

AGRICULTURAL SCHOOL.

The object of this school -where twenty to twenty-five boys, from fifteen to nineteen years of age, are thoroughly trained in the scientific and practical details of garden and field work—is to supply skilled assistants on estates and raise a class of agriculturists that will have a sound practical knowledge in raising and curing such crops. as are suited to the condition of the island. They will be working, and not theoretical agriculturists, and it is hoped they will remain, and by their own success encourage others to follow their example. A visit to the school will convince any one of the wisdom of starting and maintaining such an institution, and I look forward with great interest to the benefits that will arise from it to the island.

EXPERIMENT PLOTS.

We are not satisfied to have a Botanic Station and an Agricultural School near Roseau: we wish to carry the usefulness of these institutions into the country districts and to reach the cultivators, even in the remotest valleys. We do this by establishing over the island model plots which serve as object lessons and encourage such operations as draining and forking the land, pruning the trees, and supplying suitable manures so as to increase both the bulk and quality of the crops. A travelling Agricultural Instructor is maintained, whose whole duty is to look after these experiment plots, give information to planters, suggest means for treating disease, and advise where and how to obtain seeds and plants for starting new industries. I am glad to acknowledge the valuable assistance

afforded to the Department by estate owners and others in connexion with these experiment plots. The work in hand cannot fail materially to improve local industries, and I estimate that if, by a system of intensive cultivation which is illustrated in these plots, we can increase the yield of limes and cacao by only a little per tree, the aggregate increase for the island would be so considerable as well to repay our efforts.

AGRICULTURAL SHOWS.

These were first started, and have since been largely subsidized, by the Imperial Department of Agriculture. I have formed a high opinion of the arrangements made for these annual Shows at Dominica. The Shows have an important educational value, and their influence is spreading to all parts of the island. I sincerely hope these Shows will be continued and efforts directed to render them of immediate benefit to all classes of the community.

INTRODUCTION OF STOCK.

Of late years steps have been taken to improve the local breed of horses, cattle, sheep, pigs, poultry, etc. The animals introduced by the Department are kept in the neighbourhood of the Agricultural School. There are two good stallions, a Maltese jack, Berkshire pigs, and several breeds of fowls, ducks, etc. All these are greatly appreciated, and it is evident that the action taken is entirely in accordance with the needs of the planting community.

TREATMENT OF INSECT PESTS.

The prevalence of insect pests is the cause of anxiety, especially to proprietors of lime and orange plantations.

In a useful summary published in the *West Indian Bulletin* (Vol. III., pages 140-51) it has been shown that there are, in the West Indies, about 120 species of scale insects. Of these thirty-two are virulently destructive; thirty-six moderately destructive and fifty-two are harmless. Of the total number, according to Mr. Maxwell-Lefroy, there are only twenty-four now found in this island. There are, therefore, ninety-six species of scale insects more or less injurious outside of Dominica, that it is in the interests of all concerned to keep out. Of the virulently destructive species the introduction of only one or two might at any time seriously injure the lime and orange trees and reduce the profits of the planters. In order to safeguard their interests it is desirable to fumigate all plants before they are admitted into the island. The process of fumigation advocated by the Department is simple and inexpensive. It affords a reliable means for destroying insect pests, and it does not injure the plants. It is hoped that an Ordinance will be passed enforcing fumigation prior to the admission of any plants into the island. The practice has been in force in Jamaica for some time. It works there smoothly and effectively.

CONTROL OF EXPORTED FRUIT.

At the Conference held at Barbados in January last, Mr. Sydney Olivier, C.M.G., the Colonial Secretary of Jamaica, read a valuable paper (*West Indian Bulletin*, Vol. III., pp. 131-39) on the desirability of regulating the quality of exported fruit. It is well known that great injury is done by the large proportion of West Indian fruit that is exported in bad condition and in unsuitable packages. Too often the oranges, for example, are uneven in sample, carelessly gathered, bumped about, pricked, bruised, the rind not properly dried and cured, and are hastily packed, and thus reach their destination in a bad condition, causing disappointment and loss.

It is admitted that it is very difficult to control effectively the quality of exported fruit. We might forbid by law the exportation of any fruit; or we might offer to give a Government guarantee for the fruit that is submitted for inspection and is found to be of first-class quality. Neither of these is likely to be practicable in this island. I suggest, at first, that Mr. Olivier's proposals be adopted—(1) that a register of all growers and packers of fruit be established, and that no person not registered and licensed be allowed to pack or ship fruit; (2) that all packages be marked with the packer's name and address, and with a mark indicative of the packing house whence they are issued. It is believed that with a rigid system of record and publicity, not only the exporter, but his neighbours would soon learn what fruit and what methods of putting up to avoid.

The system indicated above would work automatically and no one could complain. The results would be exactly in accordance with the care and trouble taken in selecting and packing the fruit. The bad packer would disappear while the honest and careful packer would prosper. Further, the good name of the island would be preserved and its productions would command uniformly high prices.

ARBOR DAY.

There is one more subject that I would wish to bring before you and that is, the establishment of an Arbor Day for the public and systematic planting of trees. It is very important that the rising generation should be accustomed to the requirements of plant life and be infused with a spirit of regard and affection for trees and check the almost universal desire now existing to cut down and destroy what might become useful and ornamental.

An Arbor Day has recently been most successfully carried out at Antigua. A good day to adopt would be the Birthday of His Majesty the King, November 9. This falls at the time of year when planting operations are successfully carried on in this island. Plants might be obtained from the Botanic Station, and the officers of this Department would cordially afford any assistance in their power.

I must now close. It only remains for me to thank you heartily for your kind attention to what I have laid before

you. I assure you, as members of the Dominica Agricultural Society, of my warm sympathy and support in the efforts you are making for the welfare of the planting (that is, practically, the entire) community of this beautiful island of Dominica.

DISCUSSION.

Mr. COLTHURST asked what was the right time for sending oranges to New York and what kind of package was best for oranges and green limes.

Dr. MORRIS suggested that oranges should be shipped in boxes and reach New York in September or soon after. Boxes, not barrels, should be used for both oranges and green limes.

In answer to a question from the same gentleman about eradicating ticks on cattle, Dr. Morris recommended a reference to an article on stock raising in Jamaica in the *West Indian Bulletin*, Vol. III, pp. 203-206.

Dr. NICHOLLS reminded Mr. Colthurst that the Society kept a Reading Room where he could obtain all such information. He then said that Mr. Watts' services had been of great value, but the island had not had enough of them. A local Agricultural Chemist was necessary and he hoped the Commissioner of Agriculture would be able to locate one here soon. Dominica, he thought, was sufficiently prosperous to help to pay his salary.

Mr. FRAMPTON thanked Dr. Morris for his address and praised the suggestion for compelling shippers of fruit to place their name and address on all packages. He thought the white fungus on the limes referred to was due to the fruit being accidentally pricked on the trees.

Dr. MORRIS said it showed the spores of the fungus were present and that if the trees are not maintained in good condition, the disease would probably spread. No doubt trees in some districts were more liable to the disease than others. Dr. Morris added that both in London and New York buyers complained that limes from Dominica sometimes developed a hardness with a whitish appearance on the skin which injured them. He could safely leave the planters in the island to deal with the matter.

Mr. FRAMPTON informed the meeting that the report on the first shipment of citrate of lime recently made at the Bath estate by Mr. Watts was very favourable. Mr. Watts had recommended that a centrifugal machine might be useful to help in drying the citrate before shipment.

The VICE-PRESIDENT (Mr. W. Rumsey Lockhart), in moving a vote of thanks to Dr. Morris, said that his words and recommendations always bore fruit. His address on cacao sixteen years ago had marked an epoch in the history of cacao cultiva-

tion in Dominica. All improvements in cacao cultivation practically dated from then. The Department of Agriculture was doing excellent work in helping the West Indies, and everyone should show his appreciation of it by following its advice.

His Honour the Chairman conveyed the thanks of the meeting to Dr. Morris. He said that Arbor Day had been a great success in Antigua, and he recommended it should become a regular institution at Dominica.

Dr. Morris expressed his thanks and stated that he was glad to find that the work of the Imperial Department of Agriculture was appreciated, especially its publications which were extensively distributed throughout these colonies. He hoped the planters in Dominica would cordially support their local Agricultural Society. It was capable of conferring great benefit on the island.

Errata in the Present Volume.

Page 80, line 20 from bottom, *for* on *read* no.

Page 127, line 24 from bottom, *for* 1902, *read* 1901.

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